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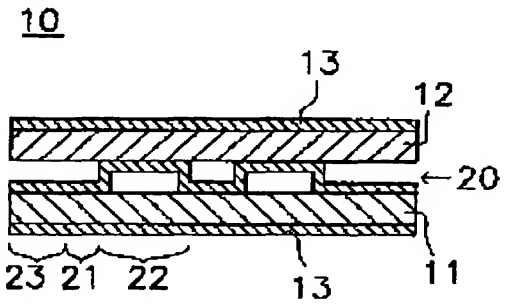
(54) COMPLEX CIRCUIT SUBSTRATE, NONREVERSIBLE CIRCUIT ELEMENT, RESONATOR, FILTER, DUPLEXER, COMMUNICATION DEVICE, CIRCUIT MODULE, MANUFACTURE OF COMPLEX CIRCUIT SUBSTRATE AND MANUFACTURE OF NONREVERSIBLE CIRCUIT ELEMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a complex circuit substrate which adjusts the physical relationship between a dielectric substrate and a magnetic substrate of an element part formed by an electrode pattern into an optional relationship and is miniaturized.
SOLUTION: Relating to this complex circuit substrate 10 which is formed by including a dielectric substrate 11, a magnetic substrate 12 arranged with an interval placed from the substrate 11 and an electrode 20 between the substrates 11 and 12, the electrode 20 makes a capacitative element part 21 adjacent to or close to the substrate 11 and an inductance element part 22 adjacent to or close to the substrate 12.



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CLAIMS

[Claim(s)]
[Claim 1] The compound circuit board to which it is the compound circuit board characterized by providing the following, and the aforementioned electrode is characterized by approaching relatively [side / dielectric substrate / aforementioned] in the position, and approaching relatively / side / magnetic-substance substrate / aforementioned] in other different positions from the aforementioned position. Dielectric substrate. The magnetic-substance substrate arranged by separating this dielectric substrate and an interval. The electrode formed between the aforementioned dielectric substrate and the aforementioned magnetic-substance substrate.
[Claim 2] The compound circuit board according to claim 1 to which the aforementioned electrode is characterized by being close or close at the aforementioned magnetic-substance substrate side in close to the aforementioned dielectric substrate, or other positions which are close and are different from the aforementioned position in a position.
[Claim 3] The compound circuit board according to claim 1 or 2 characterized by arranging the matter which has a dielectric constant lower than the dielectric constant of this dielectric substrate between the electrodes and the aforementioned dielectric substrates near the aforementioned magnetic-substance substrate side.
[Claim 4] The compound circuit board according to claim 1, 2, or 3 characterized by forming the electrode near the aforementioned dielectric substrate side, and the electrode near the aforementioned magnetic-substance substrate side by one.
[Claim 5] The compound circuit board according to claim 1, 2, or 3 to which the substrate which has the surface electrode through which it flowed by the through hole, and a rear-face electrode is characterized by being arranged between the aforementioned dielectric substrate and the aforementioned magnetic-substance substrate.
[Claim 6] The compound circuit board according to claim 1, 2, 3, 4, or 5 characterized by forming capacitative element by the electrode near the aforementioned dielectric substrate side, and forming the inductance element by the electrode near the aforementioned magnetic-substance substrate.
[Claim 7] The compound circuit board according to claim 1 to 6 which the dielectric substrate is arranged partially at the portion in which the electrode near the aforementioned dielectric substrate at least exists, or is characterized by arranging the magnetic-substance substrate partially at the portion in which the electrode near the aforementioned magnetic-substance substrate at least exists.
[Claim 8] The non-reciprocal circuit element characterized by the bird clapper including the compound circuit board according to claim 6 or 7 which has two or more inductance element sections which cross mutually, and the capacitative-element section connected to this inductance element section, and the magnet for impressing a direct-current magnetic field.
[Claim 9] The resonator characterized by having formed capacitative element and the inductance element by the electrode arranged between the aforementioned dielectric substrate of a claim 1 or the compound circuit board given in seven, and the aforementioned magnetic-substance substrate, and constituting a resonance circuit.
[Claim 10] The filter characterized by the bird clapper including a resonator according to claim 9

and the means for I/O connection.
[Claim 11] The duplexer characterized by being the duplexer which comes to contain at least two filters, the means for I/O connection connected to each of this filter, and the means for antenna connection connected to the aforementioned filter in common, and at least one of the aforementioned filters being a filter according to claim 10.
[Claim 12] The transmitter equipment characterized by the bird clapper including a duplexer according to claim 11, the circuit for transmission connected to at least one means for I/O connection of this duplexer, the circuit for reception which are connected to at least one different means for I/O connection from the aforementioned means for I/O connection connected to this circuit for transmission, and the antenna which are connected to the means of the aforementioned duplexer for antenna connection.
[Claim 13] The circuit module characterized by having at least one functional device formed using the compound circuit board according to claim 1 to 7.
[Claim 14] The non-reciprocal circuit element characterized by being the non-reciprocal circuit element characterized by providing the following, approaching relatively [side / dielectric substrate / aforementioned] in the transmission-line portion of the aforementioned electrode, and approaching relatively / side / magnetic-substance substrate / aforementioned] in the resonator portion of the aforementioned electrode. Dielectric substrate. The magnetic-substance substrate arranged by separating this dielectric substrate and an interval. The electrode which consisted of a resonator portion and a transmission-line portion, and was formed between the aforementioned dielectric substrate and the aforementioned magnetic-substance substrate. The magnet for impressing a direct-current magnetic field.
[Claim 15] It sets into the transmission-line portion of the aforementioned electrode, and they are close to the aforementioned dielectric substrate, or the non-reciprocal circuit element according to claim 14 which is close and is characterized by being close or close in the resonator portion of the aforementioned electrode at the aforementioned magnetic-substance substrate side.
[Claim 16] The non-reciprocal circuit element according to claim 14 or 15 characterized by arranging the matter which has a dielectric constant lower than the dielectric constant of this dielectric substrate between the resonator portions of an electrode and the aforementioned dielectric substrates near the aforementioned magnetic-substance substrate side.
[Claim 17] The non-reciprocal circuit element according to claim 14, 15, or 16 to which the substrate which has the surface electrode through which it flowed by the through hole, and a rear-face electrode is characterized by being arranged between the aforementioned dielectric substrate and the aforementioned magnetic-substance substrate.
[Claim 18] The non-reciprocal circuit element according to claim 14 to 17 which the dielectric substrate is arranged or is partially characterized by arranging the magnetic-substance substrate partially at the portion in which the electrode which serves as a resonator portion at least exists at the portion in which the electrode which serves as a transmission-line portion at least exists.
[Claim 19] Transmitter equipment characterized by the bird clapper including a claim 14 or a non-reciprocal circuit element given in 18, the circuit for transmission and the circuit for reception, and an antenna.
[Claim 20] The manufacture method of the compound circuit board characterized by the bird clapper including the process which prepares a dielectric substrate, the process which forms a low dielectric constant film in the aforementioned dielectric substrate by the matter which has a dielectric constant lower than the dielectric constant of this dielectric substrate, the process which forms an electrode pattern in the dielectric substrate in which the aforementioned low dielectric constant film was formed, and the process which pastes up a magnetic-substance substrate on the dielectric substrate in which the aforementioned electrode pattern was formed.
[Claim 21] The manufacture method of the compound circuit board characterized by the bird clapper including the process which you form [process] an electrode pattern in the front rear face of the low dielectric constant substrate which has a dielectric constant lower than the process which prepares a dielectric substrate, the process which prepares a magnetic-substance substrate, and the dielectric constant of the aforementioned dielectric substrate, and

makes it flow through a surface electrode and a rear-face electrode in a through hole, and the process which pastes up the aforementioned dielectric substrate and the aforementioned magnetic-substance substrate so that the aforementioned low dielectric constant substrate may

[Claim 22] The process which prepares a dielectric substrate, and the process which forms an electrode pattern in the aforementioned dielectric substrate, The process which prepares a magnetic-substance substrate, and the process which forms an electrode pattern in the aforementioned magnetic-substance substrate, The electrode pattern side of the aforementioned dielectric substrate and the electrode pattern side of the aforementioned magnetic-substance substrate counter. It arranges so that the electrode pattern of the aforementioned dielectric substrate and the electrode pattern of the aforementioned magnetic-substance substrate may counter in a part for a further predetermined connection. The manufacture method of the compound circuit board characterized by the bird clapper including the process which connects the electrode pattern of the aforementioned dielectric substrate, and the electrode pattern of the aforementioned magnetic-substance substrate by part for a connection predetermined [aforementioned].
[Claim 23] The manufacture method of the non-reciprocal circuit element characterized by providing the following. The process which prepares a dielectric substrate. The process which forms a low dielectric constant film in the aforementioned dielectric substrate by the matter which has a dielectric constant lower than the dielectric constant of this dielectric substrate. The process which forms an electrode pattern so that it may become the aforementioned low dielectric constant film formation portion of the dielectric substrate in which the aforementioned low dielectric constant film was formed with a transmission-line portion at a resonator portion and other portions. The process which pastes up a magnetic-substance substrate on the dielectric substrate in which the aforementioned electrode pattern was formed, and the process which prepares and arranges the magnet for impressing a direct-current magnetic field.
[Claim 24] The manufacture method of the non-reciprocal circuit element characterized by providing the following. The process which prepares a dielectric substrate. The process which prepares a magnetic-substance substrate. The process which you form [process] the electrode pattern used as a resonator portion and a transmission-line portion in the front rear face of the low dielectric constant substrate which has a dielectric constant lower than the dielectric constant of the aforementioned dielectric substrate, and makes it flow through a surface electrode and a rear-face electrode in a through hole. The process which pastes up the aforementioned dielectric substrate and the aforementioned magnetic-substance substrate so that it may become a dielectric substrate at the magnetic-substance substrate and transmission-line portion side of the aforementioned electrode pattern at the resonator portion side of the aforementioned electrode pattern so that the aforementioned low dielectric constant substrate may be pinched, and the process which prepares and arranges the magnet for impressing a direct-current magnetic field.
[Claim 25] The process which prepares a dielectric substrate, and the process which forms the electrode pattern used as a transmission-line portion in the aforementioned dielectric substrate, The process which prepares a magnetic-substance substrate, and the process which forms the electrode pattern used as a resonator portion in the aforementioned magnetic-substance substrate, The electrode pattern side, the aforementioned magnetic-substance substrate, and electrode pattern side of the aforementioned dielectric substrate counter. It arranges so that the electrode pattern of the aforementioned dielectric substrate and the electrode pattern of the aforementioned magnetic-substance substrate may counter in a part for a further predetermined connection. The manufacture method of the non-reciprocal circuit element characterized by the bird clapper including the process which connects the electrode pattern of the aforementioned dielectric substrate, and the electrode pattern of the aforementioned magnetic-substance substrate, and the process which prepares and arranges the magnet for impressing a direct-current magnetic field by part for a connection predetermined [aforementioned].

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the manufacture method of the compound circuit board, and the manufacture method of a non-reciprocal circuit element at the compound circuit board whose electrode was pinched between the dielectric substrate and the magnetic-substance substrate, a non-reciprocal circuit element, a resonator, a filter, a duplexer, transmitter equipment, a circuit module, and a row.
[0002]
[Description of the Prior Art] What carried out the laminating of the dielectric substrate and magnetic-substance substrate in which electrode patterns, such as capacitative element and an inductance element, were formed to multi-stage, and formed the resonance circuit etc. from before is considered. Moreover, the compound circuit board which low back-ization may be called for according to a use, a request property, etc. by one side, and fills such a demand is devised conventionally.
[0003] Then, the conventional compound circuit board is explained based on drawing 23 and 24. In addition, drawing 23 is the plan of the conventional compound circuit board, and drawing 24 is a W-W line cross section in drawing 23. As shown in drawing 23 and 24, the conventional compound circuit board 110 consists of a dielectric substrate 111, a magnetic-substance substrate 112, and an electrode pattern 120 inserted between them. The electrode pattern 120 consists of the capacitative-element section 121, the inductance element section 122, the transmission-line section 123, etc., and the ground electrode 113 is formed in the outside side of the dielectric substrate 111 and the magnetic-substance substrate 112. The compound circuit board 110 is functioning as a low pass filter by making it such composition here.
[0004] this conventional compound circuit board 110 -- setting -- formation of the electrode pattern 120 -- first -- plating etc. -- the dielectric substrate 111 and the magnetic-substance substrate 112 -- Electrodes 120a and 120b are formed in the position which counters, respectively, and connection electrode 120c is further formed on it and connection electrode 120c -- minding -- the dielectric substrate 111 and the magnetic-substance substrate 112 -- the electrode pattern 120 is formed by sticking the electrodes 120a and 120b which were alike, respectively and were formed
[0005]
[Problem(s) to be Solved by the Invention] As for capacitative element, an inductance element, resistance, the transmission line that are formed in the compound circuit board, the property changes with physical relationship with a dielectric substrate, and physical relationship with a magnetic-substance substrate. For example, an inductance element can obtain an inductance with the big one near a magnetic-substance substrate to some extent, and can miniaturize the one near a magnetic-substance substrate in the same inductance value. Similarly, the one near a dielectric substrate can obtain a big capacity, and capacitative element can miniaturize the one near a dielectric substrate in the same capacity value.
[0006] However, in the conventional compound circuit board, since the electrode pattern inserted into the dielectric substrate and the magnetic-substance substrate sticks the electrode

formed in a dielectric substrate and each magnetic-substance substrate and is formed, all electrode patterns are in a coplanar. That is, all of the capacitative element formed with the electrode pattern, an inductance element, resistance, the transmission line, etc. are a dielectric substrate and the equal distance, and they are the equal distance in a magnetic-substance substrate further.

[0007] Moreover, although, as for an inductance element, the one near a magnetic-substance substrate can obtain a big inductance, if a dielectric substrate is in near, combination with a dielectric will become strong and an inductance value will fall. Moreover, in the case of a distributed constant type non-reciprocal circuit element, among the electrodes which consist of a resonator portion and a transmission-line portion, when the way which brought the resonator portion close to a magnetic-substance substrate impresses a direct-current magnetic field, the irreversibility of an element improves, for example. However, if a dielectric substrate is in near, combination with a dielectric will become strong and the irreversibility of an element will fall.

[0008] Therefore, when capacitative element, an inductance element, etc. which were formed by the electrode pattern inserted into a dielectric substrate and a magnetic-substance substrate were in the same plane, the limitation arose, for example in improvement in an inductance value, and there was a problem that the miniaturization of an element, as a result the miniaturization of the compound circuit board could not be performed. Moreover, there was a problem that a delicate design could not be performed about properties, such as capacitative element, an inductance element, resistance, and the transmission line.

[0009] In the compound circuit board of this invention, a non-reciprocal circuit element, a resonator, a filter, a duplexer, transmitter equipment, a circuit module, and a row, the manufacture method of the compound circuit board, and the manufacture method of a non-reciprocal circuit element It is made in view of an above-mentioned problem, solve these problems, and it has a good property. It aims at providing with the manufacture method of the compound circuit board, and the manufacture method of a non-reciprocal circuit element the compound circuit board which can be miniaturized, a non-reciprocal circuit element, a resonator, a filter, a duplexer, transmitter equipment, a circuit module, and a row.

[0010]

[Means for Solving the Problem] In order to attain the above-mentioned purpose the compound circuit board of this invention A dielectric substrate and the magnetic-substance substrate arranged by separating this dielectric substrate and an interval, It is the compound circuit board which comes to contain the electrode formed between the aforementioned dielectric substrate and the aforementioned magnetic-substance substrate, and the aforementioned electrode is approaching relatively [side / dielectric substrate / aforementioned] in the position, and is approaching relatively / side / magnetic-substance substrate / aforementioned] in other different positions from the aforementioned position. Since distance with an inductance element, capacitative element, resistance, the transmission line that were formed with the electrode pattern, a dielectric substrate, or a magnetic-substance substrate is made to a desired value by this, the degree of combination with an element, and each dielectric substrate and magnetic-substance substrate can be designed individually, and the property of each element can be designed delicately.

[0011] For example, when a ferrite substrate is used as a magnetic-substance substrate, the dielectric constant is ten to about 15, a dielectric dissipation factor is 1x10-3 to 1x10 to about four, and permeability is one or more further. The dielectric constant of the dielectric substrate generally used on the other hand is ten to about 100, a dielectric dissipation factor is 5x10-4 to 1x10 to about five, and permeability is 1 further. For this reason, an effective dielectric constant becomes large and the direction which brought the electrode close to a dielectric substrate in capacitative element can obtain big capacity value. Moreover, in the same capacity value, the direction with the electrode near a dielectric substrate can miniaturize capacitative element. Moreover, about transmission loss, the direction which brought the electrode close to a dielectric with a dielectric dissipation factor small in general can realize the transmission line of low loss. Furthermore, the effective permeability becomes large and the direction which brought the electrode close to a magnetic-substance substrate in the inductance element can acquire a

big inductance value. Moreover, in the same inductance value, the direction with the electrode near a magnetic-substance substrate can miniaturize an inductance element.
[0012] moreover, the compound circuit board concerning a claim 2 has the aforementioned electrode close to the aforementioned magnetic-substance substrate side in close to the aforementioned dielectric substrate, or other positions which are close and are different from the aforementioned position in a position -- or it is close As for close to a dielectric substrate, or the electrode of a position which approached, combination with a dielectric becomes strong by this, and, as for close to a magnetic-substance substrate, or the electrode of a position which approached, combination with the magnetic substance becomes strong.
[0013] Furthermore, the matter which has a dielectric constant lower than the dielectric constant of this dielectric substrate between electrodes and the aforementioned dielectric substrates with the compound circuit board near the aforementioned magnetic-substance substrate side concerning a claim 3 is arranged. Combination with the electrode near a magnetic-substance substrate side and a dielectric substrate can be weakened by this, and the effect acquired by bringing close to the magnetic substance is not spoiled.
[0014] The electrode with the compound circuit board near the aforementioned dielectric substrate side concerning a claim 4 and the electrode near the aforementioned magnetic-substance substrate side are formed by one further again. The need that this connects the electrode formed in the dielectric substrate and the electrode formed in the magnetic-substance substrate is lost, and the fall of the reliability produced by connection and the time and effort on manufacture can be saved.
[0015] The substrate which has the surface electrode which flowed through the compound circuit board concerning a claim 5 by the through hole, and a rear-face electrode is arranged between the aforementioned dielectric substrate and the aforementioned magnetic-substance substrate further again. Thereby, the compound circuit board can be easily formed by adhesion with a dielectric substrate and a magnetic-substance substrate, and the substrate in which the electrode pinched among them was formed.
[0016] Capacitative element is formed by the electrode with the compound circuit board near the aforementioned dielectric substrate side concerning a claim 6, and the inductance element is formed by the electrode near the aforementioned magnetic-substance substrate further again. Thereby, in the capacitative element of the same capacity, it can miniaturize compared with the former and can miniaturize compared with the former with the inductance element of the same inductance.
[0017] As for the compound circuit board concerning a claim 7, the magnetic-substance substrate is arranged partially further again at the portion to which the dielectric substrate is partially arranged or the electrode near the aforementioned magnetic-substance substrate at least exists in the portion in which the electrode near the aforementioned dielectric substrate at least exists. Thereby, since what is necessary is to arrange a dielectric substrate or a magnetic-substance substrate only into a required portion, the futility of a dielectric substrate or a magnetic-substance substrate can be excluded.
[0018] The non-reciprocal circuit element concerning a claim 8 comes to contain the compound circuit board according to claim 6 or 7 which has two or more inductance element sections which cross mutually, and the capacitative-element section connected to this inductance element section, and the magnet for impressing a direct-current magnetic field further again. Thereby, the inductance element section of a non-reciprocal circuit element approaches a magnetic-substance substrate, and the capacitative-element section approaches a dielectric substrate and can miniaturize a non-reciprocal circuit element.
[0019] The resonator concerning a claim 9 formed capacitative element and the inductance element by the electrode arranged between the aforementioned dielectric substrate of a claim 1 or the compound circuit board given in seven, and the aforementioned magnetic-substance substrate, and constituted the resonance circuit further again. By this, the inductance element of a resonator approaches a magnetic-substance substrate, capacitative element approaches a dielectric substrate, and a resonator can be miniaturized.
[0020] The filter concerning a claim 10 comes to contain a resonator according to claim 9 and

the means for I/O connection further again. By this, the inductance element of a filter approaches a magnetic-substance substrate, capacitative element approaches a dielectric substrate, and a filter can be miniaturized.
[0021] The duplexer concerning a claim 11 is a duplexer which comes to contain at least two filters, the means for I/O connection connected to each of this filter, and the means for antenna connection connected to the aforementioned filter in common, and at least one of the aforementioned filters is a filter according to claim 10 further again. By this, the inductance element of a duplexer approaches a magnetic-substance substrate, capacitative element approaches a dielectric substrate, and a duplexer can be miniaturized.
[0022] The transmitter equipment concerning a claim 12 comes to contain further again in a duplexer according to claim 11, the circuit for transmission which are connected to at least one means for I/O connection of this duplexer, the circuit for reception which are connected to at least one different means for I/O connection from the aforementioned means for I/O connection connected to this circuit for transmission, and the antenna which are connected to the means of the aforementioned duplexer for antenna connection. By this, the inductance element of for example, transmitter equipment approaches a magnetic-substance substrate, capacitative element approaches a dielectric substrate, and transmitter equipment can be miniaturized.
[0023] The circuit module of this invention has at least one functional device formed using the compound circuit board according to claim 1 to 7 further again. By this, the inductance element of for example, a circuit module approaches a magnetic-substance substrate, capacitative element approaches a dielectric substrate, and a circuit module can be miniaturized.
[0024] The magnetic-substance substrate arranged further again by the non-reciprocal circuit element of this invention separating a dielectric substrate, this dielectric substrate, and an interval, The electrode which consisted of a resonator portion and a transmission-line portion, and was formed between the aforementioned dielectric substrate and the aforementioned magnetic-substance substrate, It is the non-reciprocal circuit element which comes to contain the magnet for impressing a direct-current magnetic field, and in the transmission-line portion of the aforementioned electrode, it is approaching relatively [side / dielectric substrate / aforementioned], and is approaching relatively / side / magnetic-substance substrate / aforementioned] in the resonator portion of the aforementioned electrode. Thereby, the transmission-line portion of an electrode approaches a dielectric substrate, and a propagation loss becomes small and is miniaturized compared with the former in the same property. Moreover, the resonator portion of an electrode approaches a magnetic-substance substrate, combination with the magnetic substance becomes strong, and irreversibility improves.
[0025] the non-reciprocal circuit element concerning a claim 15 is close to the aforementioned dielectric substrate in the transmission-line portion of the aforementioned electrode further again -- or close [in / the resonator portion of the aforementioned electrode / it is close and] to the aforementioned magnetic-substance substrate side -- or it is close As for close to a dielectric substrate, or the electrode of a position which approached, combination with a dielectric becomes strong by this, and, as for close to a magnetic-substance substrate, or the electrode of a position which approached, combination with the magnetic substance becomes strong.
[0026] The matter which has a dielectric constant lower than the dielectric constant of this dielectric substrate is arranged further again between the resonator portions of an electrode and the aforementioned dielectric substrates with the non-reciprocal circuit element near the aforementioned magnetic-substance substrate side concerning a claim 16. Combination with the electrode near a magnetic-substance substrate side and a dielectric substrate can be weakened by this, and the effect acquired by bringing close to the magnetic substance is not spoiled.
[0027] The substrate which has the surface electrode through which the non-reciprocal circuit element concerning a claim 17 flowed by the through hole, and a rear-face electrode is arranged between the aforementioned dielectric substrate and the aforementioned magnetic-substance substrate further again. Thereby, a non-reciprocal circuit element can be easily formed by adhesion with a dielectric substrate and a magnetic-substance substrate, and the substrate in which the electrode pinched among them was formed.

[0028] The dielectric substrate is arranged by the portion in which the electrode from which the non-reciprocal circuit element concerning a claim 18 serves as a transmission-line portion at least exists, or the magnetic-substance substrate is partially arranged into it further again at the portion in which the electrode which serves as a resonator portion at least exists. Thereby, since what is necessary is to arrange a dielectric substrate or a magnetic-substance substrate only into a required portion, the futility of a dielectric substrate or a magnetic-substance substrate can be excluded.
[0029] The transmitter equipment concerning a claim 19 comes to contain a claim 14 or a non-reciprocal circuit element given in 18, the circuit for transmission and the circuit for reception, and an antenna further again. By this, the transmission-line portion of a non-reciprocal circuit element approaches a dielectric substrate side, a resonator portion approaches a magnetic-substance substrate side, the property of transmitter equipment becomes good, and transmitter equipment can be miniaturized further.
[0030] The manufacture method of the compound circuit board which starts a claim 20 further again comes to contain the process which prepares a dielectric substrate, the process which is the matter which has a dielectric constant lower than the dielectric constant of this dielectric substrate, and forms a low dielectric constant film in the aforementioned dielectric substrate, the process which form an electrode pattern in the dielectric substrate in which the aforementioned low dielectric constant film was formed, and the process which paste up a magnetic-substance substrate on the dielectric substrate in which the aforementioned electrode pattern was formed. The electrode of the compound circuit board which has by this the electrode pattern which approached the dielectric substrate or the magnetic-substance substrate by the position can be formed at once.
[0031] The manufacture method of the compound circuit board which starts a claim 21 further again forms an electrode pattern in the front rear face of the low dielectric constant substrate which has a dielectric constant lower than the process which prepares a dielectric substrate, the process which prepares a magnetic-substance substrate, and the dielectric constant of the aforementioned dielectric substrate, and comes to contain the process which makes it flow through a surface electrode and a rear-face electrode in a through hole, and the process which paste up the aforementioned dielectric substrate and the aforementioned magnetic-substance substrate so that the aforementioned low dielectric constant substrate It can form easily by pasting up the substrate in which the electrode into which the compound circuit board which has by this the electrode pattern which approached the dielectric substrate or the magnetic-substance substrate by the position is inserted between a dielectric substrate and a magnetic-substance substrate, and them was formed.
[0032] The manufacture method of the compound circuit board concerning a claim 22 further again The process which prepares a dielectric substrate, and the process which forms an electrode pattern in the aforementioned dielectric substrate, The process which prepares a magnetic-substance substrate, and the process which forms an electrode pattern in the aforementioned magnetic-substance substrate, The electrode pattern side of the aforementioned dielectric substrate and the electrode pattern side of the aforementioned magnetic-substance substrate counter. It arranges so that the electrode pattern of the aforementioned dielectric substrate and the electrode pattern of the aforementioned magnetic-substance substrate may counter in a part for a further predetermined connection, and it comes to contain the process which connects the electrode pattern of the aforementioned dielectric substrate, and the electrode pattern of the aforementioned magnetic-substance substrate by part for a connection predetermined [aforementioned]. The electrode pattern of a position can be brought close to a dielectric substrate side using the flip chip mounting technology generally used by this, and the electrode pattern of another position can be brought close to a magnetic-substance substrate.
[0033] The manufacture method of the non-reciprocal circuit element concerning a claim 23 further again By the process which prepares a dielectric substrate, and the matter which has a dielectric constant lower than the dielectric constant of this dielectric substrate The process which forms a low dielectric constant film in the aforementioned dielectric substrate, and th

process which forms an electrode pattern so that it may become the aforementioned low dielectric constant film formation portion of the dielectric substrate in which the aforementioned low dielectric constant film was formed with a transmission-line portion at a resonator portion and other portions, It comes to contain the process which pastes up a magnetic-substance substrate on the dielectric substrate in which the aforementioned electrode pattern was formed, and the process which prepares and arranges the magnet for impressing a direct-current magnetic field. The electrode of the non-reciprocal circuit element which has by this the electrode pattern which approached the dielectric substrate or the magnetic-substance substrate by the position can be formed at once.

[0034] The manufacture method of the non-reciprocal circuit element concerning a claim 24 further again The electrode pattern used as a resonator portion and a transmission-line portion is formed in the front rear face of the low dielectric constant substrate which has a dielectric constant lower than the process which prepares a dielectric substrate, the process which prepares a magnetic-substance substrate, and the dielectric constant of the aforementioned dielectric substrate. So that the process which makes it flow through a surface electrode and a rear-face electrode in a through hole, and the aforementioned low dielectric constant substrate may be pinched the aforementioned dielectric substrate and the aforementioned magnetic-substance substrate It comes to contain the process pasted up so that it may become [the resonator portion side of the aforementioned electrode pattern] a dielectric substrate at the magnetic-substance substrate and transmission-line portion side of the aforementioned electrode pattern, and the process which prepares and arranges the magnet for impressing a direct-current magnetic field. It can form easily by pasting up the substrate in which the electrode by which the non-reciprocal circuit element which has by this the electrode pattern which approached the dielectric substrate or the magnetic-substance substrate by the position is pinched between a dielectric substrate and a magnetic-substance substrate, and them was formed.

[0035] The manufacture method of the non-reciprocal circuit element concerning a claim 25 further again The process which prepares a dielectric substrate, and the process which forms the electrode pattern used as a transmission-line portion in the aforementioned dielectric substrate, The process which prepares a magnetic-substance substrate, and the process which forms the electrode pattern used as a resonator portion in the aforementioned magnetic-substance substrate, The electrode pattern side, the aforementioned magnetic-substance substrate, and electrode pattern side of the aforementioned dielectric substrate counter. It arranges so that the electrode pattern of the aforementioned dielectric substrate and the electrode pattern of the aforementioned magnetic-substance substrate may counter in a part for a further predetermined connection. It comes to contain the process which connects the electrode pattern of the aforementioned dielectric substrate, and the electrode pattern of the aforementioned magnetic-substance substrate by part for a connection predetermined [aforementioned], and the process which prepares and arranges the magnet for impressing a direct-current magnetic field. The electrode pattern of a position can be brought close to a dielectric substrate side using the flip chip mounting technology generally used by this, and the electrode pattern of another position can be brought close to a magnetic-substance substrate.

[0036]

[Embodiments of the Invention] Hereafter, the compound circuit board which is the example of this invention is explained based on drawing 1 and 2. In addition, drawing 1 is the plan of the compound circuit board of this invention, and drawing 2 is a X-X line cross section in drawing 1. As shown in drawing 1 and 2, the compound circuit board 10 of this invention consists of a dielectric substrate 11, a magnetic-substance substrate 12, and an electrode pattern 20 inserted among them. The ground electrode 13 is formed in the outside side of the magnetic-substance substrate 12 which consists of a dielectric substrate 11 which the electrode pattern 20 consists of the capacitative-element section 21, the inductance element section 22 or the transmission-line section 23, etc., for example, consists of CaTiO3, and a ferrite. The compound circuit board 10 is functioning as a low pass filter by making it composition like drawing 1 here.

[0037] As shown in drawing 2, in the compound circuit board 10 of this invention, the

capacitative-element section 21 of the electrode pattern 20 is close to the dielectric substrate 11, and the inductance element section 22 is close to the magnetic-substance substrate 12. Thus, if the capacitative-element section 21 is made close to the dielectric substrate 11, the capacity value of the capacitative-element section 21 will become large. Therefore, it can miniaturize compared with the compound circuit board in the conventional structure of the same capacity value. Moreover, if the inductance element section 22 is made close to the magnetic-substance substrate 12, combination with the dielectric substrate 11 will become weak, and the inductance value of the inductance element section 22 will become large. Therefore, it can miniaturize compared with the compound circuit board in the conventional structure of the same inductance value. Furthermore, although not illustrated, it has the influence of a propagation loss changing with the distance relation between the dielectric substrate 11 and the magnetic-substance substrate 12 etc. also about resistance the transmission-line section 23 and here. Therefore, the transmission-line section 23 and the property of resistance can be designed delicately, and a demand property can be made to agree easily by into which position between the dielectric substrate 11 and the magnetic-substance substrate 12 the transmission-line section 23 and the arrangement position of resistance are made.

[0038] Next, the second example in the compound circuit board of this invention is explained based on drawing 3. In addition, a same sign is given to the same section as a previous example, and detailed explanation is omitted. As shown in drawing 3, compound circuit board 10a of this example consists of low dielectric constant matter 14 inserted by the dielectric substrate 11, the magnetic-substance substrate 12, the electrode pattern 20 inserted among them, the electrode pattern 20, and the dielectric substrate 11. In addition, the low dielectric constant matter 14 is good here, if it is the matter which has a dielectric constant smaller than the dielectric constant of the dielectric substrate 11 and is the matter which has a dielectric constant still smaller than the dielectric constant of the magnetic-substance substrate 12. The position where the low dielectric constant matter 14 is inserted between the dielectric substrate 11 and the electrode pattern 20 is a position in which the inductance element section 22 is formed, for example, as for the inductance element section 22, combination with the dielectric substrate 11 becomes weaker with the low dielectric constant matter 14 compared with the case where form heights in the dielectric substrate 11 and the inductance element section 22 approaches the magnetic-substance substrate 12. That is, compared with the case where form heights in the dielectric substrate 11 for the effect acquired by combination with the magnetic-substance substrate 12 being reduced by combination with the dielectric substrate 11, and the inductance element section 22 is brought close to the magnetic-substance substrate 12, this low dielectric constant matter 14 protects.

[0039] In addition, in the above example, although the electrode pattern inserted by the dielectric substrate and the magnetic-substance substrate is close to the dielectric substrate or the magnetic-substance substrate in one side, as for the inductance element close to a magnetic-substance substrate, it is good to insert the low dielectric constant matter between magnetic-substance substrates, and to make it approach with a magnetic-substance substrate. This is explained based on a simulation result.

[0040] Drawing 4 is the conceptual diagram which formed the electrode 20 between the dielectric substrate 11 arranged by separating an interval, and the magnetic-substance substrate 12, and drawing 5 is as a result of [which shows the gap G of the electrode 20 and dielectric substrate 11, the relation of an inductance L and the relation between a gap G and capacity C] a simulation. In addition, the dielectric substrates 11 are the thickness of 0.5mm, a dielectric constant 90, and permeability 1, and the magnetic-substance substrates 12 are the thickness of 0.5mm, a dielectric constant 15, and permeability 3. Moreover, the interval of the dielectric substrate 11 and the magnetic-substance substrate 12 is 0.03mm, and the thickness of an electrode 20 is 0.01mm. Moreover, ** shows capacity C and O shows an inductance L. As shown in drawing 5, although the way where capacity C is close to the dielectric substrate 11 becomes large, the position where the inductance L separated from the magnetic-substance substrate 12 0.005mm serves as the maximum. That is, the inductance element section is made to approach rather than it makes it close to the magnetic-substance substrate 12, and I hear that it is

[direction] good and there is.
[0041] Moreover, in these examples, the electrode pattern inserted into a dielectric substrate and a magnetic-substance substrate is not close to a magnetic-substance substrate, or the thing to restrict to this, although it is close. For example, like compound circuit board 10b shown in drawing 6, the low dielectric constant substrate object 15 is inserted between the magnetic-substance substrate 12 and the electrode pattern 20, and altogether, as for the inductance element section 22, the electrode pattern 20 is approaching relatively [side / magnetic-substance substrate 12] as compared with the capacitative-element section 21, even when close to the dielectric substrate 11 side. Also in this case, a book
[0042] Below, the manufacture method of the compound circuit board of this invention is explained. First, the dielectric substrate by which the ground electrode was formed in one field is prepared, and a low dielectric constant film is formed in the dielectric substrate of the position used as an inductance element by the epoxy resin, polyimide resin, etc. Then, electrode patterns, such as capacitative element, an inductance element, and the transmission line, are formed by plating, sputtering, etc. on the dielectric substrate containing a low dielectric constant film. And the compound circuit board as shown in the second example is obtained by pasting up the magnetic-substance substrate by which the ground electrode was formed in one field. If this manufacture method is used, an electrode pattern can be formed at once and the compound circuit board can be easily formed compared with the method of connecting using the conventional connection electrode.
[0043] In addition, in this example, the adhesion of a dielectric substrate and an electrode pattern is thought as important, and although the example which forms an electrode pattern in a dielectric substrate side was shown, you may form an electrode pattern in a magnetic-substance substrate side conversely. However, if the manufacture method shown in this example is used, the glue line between an electrode pattern and a magnetic-substance substrate turns into a low dielectric constant layer as it is, and can prepare a moderate gap between magnetic-substance substrates in the inductance element section. Moreover, although the example which accepts a low dielectric constant film further and prepares it here was shown, depending on a place, a low dielectric constant film can be made into a multilayer, distance with a dielectric substrate or a magnetic-substance substrate can be made into a suitable distance for every element formed by the electrode pattern, and the property of the compound circuit board can also be designed delicately.
[0044] Furthermore, other manufacture methods are explained. First, an electrode pattern is prepared in the front rear face of low dielectric constant substrates, such as a resin substrate. The electrode pattern used as an inductance element is formed in one field, the electrode pattern used as capacitative element or the transmission line is formed in the field of another side, and it is made to flow through the electrode pattern on the rear face of front by the through hole 17 here. And it pastes up on both sides of the low dielectric constant substrate by which the electrode pattern was formed between the dielectric substrate by which the ground electrode was formed in one field, and the magnetic-substance substrate. By such manufacture method, compound circuit board 10c as shown in drawing 7 is obtained.
[0045] Next, the non-reciprocal circuit element of this invention is explained based on drawing 8 and 9. In addition, drawing 8 is the decomposition perspective diagram of the non-reciprocal circuit element of this invention, and drawing 9 is the Y-Y line cross section of the compound circuit board portion in drawing 8. As shown in drawing 8 and 9, the non-reciprocal circuit element 30 of this invention consists of a 10d portion of compound circuit boards, a magnet 31 for impressing a direct-current magnetic field, and a case 32 that contains them. 10d portion of compound circuit boards consists of the dielectric substrate 11, a magnetic-substance substrate 12 which consists of a ferrite etc., and a center electrode 20 pinched among them. Center electrodes 20 are three electrodes which crossed at the angle of 120 degrees, respectively, an end is connected to an I/O electrode side and the other end is connected to the ground.
[0046] In case a center electrode 20 is formed, the low dielectric constant film 14 is formed in the position which serves as the inductanc element section 22 of a center electrode 20 in the dielectric substrate 11 by which the ground electrode 13 was formed in th rear face, and one

center electrode 20 containing the capacitative-element section 21 for taking the inductance element section 22 and adjustment by plating etc. is formed. Then, on both sides of an insulator layer 26, 2 Motome's center electrode 20 is formed like eye one book in between, and the center electrode 20 of eye further 3 books is formed. And the magnetic-substance substrate 12 in which the ground electrode 13 was formed is pasted up on the dielectric substrate 11 in which the center electrode 20 was formed, and 10d portion of compound circuit boards is formed. three center electrodes 20 -- it connects with I/O electrode 16a insulated in each ground electrode 13 with which the edge was formed in the rear face of the dielectric substrate 11 of connection electrode 16b etc. on the other hand, and the other end is connected to the ground electrode 13 of dielectric substrate 11 rear face by the through hole 17 etc. Thus, when 10d of formed compound circuit boards is contained by the case 32 with the magnet 31 arranged at the upper part of the magnetic-substance substrate 12, the non-reciprocal circuit element 30 is constituted.

[0047] In the non-reciprocal circuit element 30 of this example, by forming the inductance element section 22 on the low dielectric constant film 14 formed in the dielectric substrate 11, and forming the capacitative-element section 21 on the dielectric substrate 11, the inductance element section 22 approaches the magnetic-substance substrate 12 side, and the capacitative-element section 21 is approaching the dielectric substrate 11 side. Therefore, since both the inductance element section 22 and the capacitative-element section 21 become small compared with the conventional non-reciprocal circuit element which has the same property, non-reciprocal circuit element 30 the very thing can also be miniaturized.

[0048] Furthermore, the duplexer 40 of this invention is explained based on drawing 10 and 11. In addition, drawing 10 is the plan of a duplexer and drawing 11 is a Z-Z line cross section in drawing 10. As shown in drawing 10 and 11, the duplexer 40 of this example consists of first filter section 50a which consists of a stripline type filter, and second filter section 50b which consists of another stripline type filter. The filter which constitutes first filter section 50a turns into a band-pass filter for transmission, and the filter with which the resonator which has different resonance frequency from first filter section 50a which constitutes second filter section 50b was formed turns into a band-pass filter for reception. The means 41 for I/O connection of first filter section 50a is connected to the external circuit for transmission, and the means 42 for I/O connection of second filter section 50b is connected to the external circuit for reception. Furthermore, the means for I/O connection of another side of first filter section 50a and the means for I/O connection of another side of second filter section 50b are unified by the means 43 for antenna connection, and are connected to the external antenna.

[0049] The duplexer 40 of such composition functions as a band-pass duplexer which passes frequency predetermined by first filter section 50a, and passes frequency which is different from previous frequency by second filter section 50b.

[0050] In the duplexer 40 of this example, by forming the inductance element section 22 of a filter on the low dielectric constant film 14 formed in the dielectric substrate 11, and forming the capacitative-element section 21 of a filter on the dielectric substrate 11, the inductance el ment section 22 approaches the magnetic-substance substrate 12 side, and the capacitative-element section 21 is approaching the dielectric substrate 11 side. Therefore, since both the inductance element section 22 and the capacitative-element section 21 become small compared with the conventional duplexer which has the same property, it miniaturizes, as a result a filter can also miniaturize a duplexer 40.

[0051] The transmitter equipment 60 which is the example of this invention is explained further again based on drawing 12. In addition, drawing 12 is the schematic diagram of the transmitter equipment of this example. As shown in drawing 12, the transmitter equipment 60 of this example consists of the duplexer 40, a circuit 51 for transmission, a circuit 52 for reception, and an antenna 53. The means for I/O connection which a previous example shows a duplexer 40, and the means for I/O connection connected with first filter section 50a in drawing 10 is connected to the circuit 51 for transmission here, and is connected with second filter section 50b is connected to the circuit 52 for reception. Moreover, the means 43 for antenna connection is connected to the antenna 53.

[0052] In the transmitter equipment 60 of this example, by forming the inductance element section on the low dielectric constant film formed in the dielectric substrate, and forming the capacitative-element section on a dielectric substrate, the inductance element section approaches a magnetic-substance substrate side, and the capacitative-element section is approaching the dielectric substrate side. Therefore, since both the inductance element section and the capacitative-element section become small compared with the conventional transmitter equipment which has the same property, transmitter equipment 60 the very thing can also be miniaturized.
[0053] A different non-reciprocal circuit element from the above-mentioned thing of this invention is explained based on drawing 13 and 14 below. In addition, drawing 13 is the plan of the non-reciprocal circuit element of this invention, and drawing 14 is an A-A line cross section in drawing 13. As shown in drawing 13 and 14, non-reciprocal circuit element 30a of this example is arranged at the upper part of the non-reciprocal circuit element main part 35 and the non-reciprocal circuit element main part 35, and consists of magnets 31 for impressing a direct-current magnetic field to the non-reciprocal circuit element main part 35. The non-reciprocal circuit element main part 35 consists of the dielectric substrate 11 and the magnetic-substance substrate 12 by which the ground electrode 13 was formed in one field, and an electrode pattern 20 inserted among them, and the electrode pattern 20 consists of a main resonator portion 24 and transmission-line partial 23a which has the crossed axes angle of 120 degrees mutually. Moreover, the matching circuit portion 25 for taking adjustment with the resonator portion 24 and transmission-line partial 23a is formed in transmission-line partial 23a.
[0054] Thus, a magnet 31 is arranged in the position corresponding to the resonator portion 24 of the electrode [as shown in drawing 15, in the crevice of a substrate 18 in which the crevice was established, turn the dielectric substrate 11 side down, are arranged, and] pattern 20 on the magnetic-substance substrate 12 in the formed non-reciprocal circuit element main part 35. And the electrode line 19 formed in the edge and substrate 18 of transmission-line partial 23a is connected by wirebonding, the connection electrode, etc. At this time, that what is necessary is just to exist on the resonator portion 24 of the electrode pattern 20 at least, by using the magnetic-substance substrate 12 somewhat smaller than the dielectric substrate 11, the magnetic-substance substrate 12 appears in a front face, and the edge of transmission-line partial 23a can connect it with the electrode line 19 of a substrate 28.
[0055] In case the non-reciprocal circuit element main part 35 of this example is formed, the low dielectric constant film 14 is formed on the dielectric substrate 11 of the position which is equivalent to the resonator portion 24 in the electrode pattern 20 first. And the electrode pattern 20 which consists of a resonator portion 24 and transmission-line partial 23a is formed on the dielectric substrate 11 containing the low dielectric constant film 14, and the magnetic-substance substrate 12 is pasted up further. The electrode pattern 20 can be formed at once by this method, and non-reciprocal circuit element 30a can be manufactured easily. Moreover, it is possible to use composition like drawing 7 mentioned above as the another formation method of a non-reciprocal circuit element main part. That is, the electrode pattern used as a resonator portion is formed in one field of a low dielectric constant substrate, and the electrode pattern used as a transmission-line portion is formed in an another side side. And after connecting the electrode pattern on the rear face of front by the through hole etc., a magnetic-substance substrate is pasted up on the field side of a resonator portion, and a dielectric substrate is pasted up on the field side of a transmission-line portion. Also by this method, an electrode pattern can be formed at once and a non-reciprocal circuit element can be manufactured easily.
[0056] Furthermore, example with the another non-reciprocal circuit element of this invention is explained based on drawing 16 and 17. In addition, drawing 16 is the decomposition perspective diagram of the non-reciprocal circuit element of this example, and drawing 17 is A'-A' line cross section. As shown in drawing 16 and 17, non-reciprocal circuit element 30b of this example consists of a dielectric substrate 11, a magnetic-substance substrate 12, and a magnet 31, the electrode pattern 20 which becomes the dielectric substrate 11 from three transmission-line partial 23b which has the crossed axes angle of 120 degrees mutually is formed, and the electrode pattern 20 used as the non-reciprocal circuit section 27 which has the crossed ax s

angle of 120 degrees mutually also in the magnetic-substance substrate 12 is formed. Furthermore, the matching circuit portion 25 is formed in transmission-line partial 23b. And it arranges so that the field in which the electrode pattern 20 in the dielectric substrate 11 was formed, and the field in which the electrode pattern 20 in the magnetic-substance substrate 12 was formed may counter, and transmission-line partial 23b of the dielectric substrate 11 and the non-reciprocal circuit section 27 of the magnetic-substance substrate 12 are connected by three places, respectively. In case such connection is made, a solder bump metallurgy bump is formed in three endpoints of the non-reciprocal circuit section 27 formed in the magnetic-substance substrate 12, and the magnetic-substance substrate 12 is mounted on the dielectric substrate 11 by the so-called flip chip mounting. In addition, although not shown in drawing 16, on the dielectric substrate 11, various functional devices are formed besides the non-reciprocal circuit element, they are connected, respectively and the circuit is constituted.

[0057] In the non-reciprocal circuit element of the above-mentioned example, as shown in drawing 14 and 17, the resonator portion 24 and the non-reciprocal circuit section 27 in the electrode pattern 20 of the non-reciprocal circuit element main part 35 are approaching the magnetic-substance substrate 12 side, and transmission-line partial 23a is approaching the dielectric substrate 11 side. By bringing transmission-line partial 23a close to the dielectric substrate 11, the propagation loss in transmission-line partial 23a decreases, and can be miniaturized compared with the conventional thing of the same property. On the other hand, irreversibility improves by bringing the resonator portion 24 and non-reciprocal circuit section 23b close to the magnetic-substance substrate 12. Moreover, since the distance of the resonator portion 24 and the dielectric substrate 11 becomes large when the low dielectric constant matter 14 exists between the resonator portion 24 of the electrode pattern 20, and the dielectric substrate 11 in a previous example For example, compared with the case where form heights in the dielectric substrate 11 and the resonator portion 24 approaches the magnetic-substance substrate 12, combination with the resonator portion 24 and the dielectric substrate 11 becomes weaker further, and the irreversibility of non-reciprocal circuit element 30a improves. Moreover, since what is necessary is to carry out flip chip mounting of the magnetic-substance substrate 12 in which the electrode pattern 20 was formed in the next example only at a required portion, the futility of the magnetic-substance substrate 12 is lost. Moreover, it is possible to use flip chip mounting technology, such as general-purpose bump connection, and manufacture becomes easy.

[0058] In addition, in an above-mentioned non-reciprocal circuit element, although explained using the thing of three terminals, this invention is applicable also to what connected the terminator to the end of the three terminals, and was made into the isolator, and the isolator of a one terminal pair network.

[0059] Next, the example which applied this invention to the circuit module in which two or more elements were formed on the same substrate is explained based on drawing 18 and 19. In addition, drawing 18 is the plan of the circuit module of this example, and drawing 19 is a B-B line cross section in drawing 18. As shown in drawing 18 and 19, the circuit module 36 of this example consists of a non-reciprocal circuit element 30c portion as a functional device, and branch circuit 37 portion. Non-reciprocal circuit element 30c is the isolator with which the resistance film 38 was connected to one terminal, and, on the other hand, the branch circuit 37 consists of capacitative-element section 21a, inductance element section 22a, and a resistance film 38.

[0060] In case such a circuit module 36 is formed, the low dielectric constant film 14 is formed in the predetermined portion 24 on the dielectric substrate 11 in which the ground electrode 13 was formed first, i.e., the resonator portion of non-reciprocal circuit element 30c, and the portion used as inductance element section 22a of a branch circuit 37, and non-reciprocal circuit element 30c and the electrode pattern 20 of a branch circuit 37 are formed on the dielectric substrate 11 containing the low dielectric constant film 14. moreover, non-reciprocal circuit element 30c and a branch circuit 37 -- it is alike, respectively and the resistance film 38 is formed And the magnetic-substance substrate 12 by which the ground electrode 13 was formed on the resonator portion 24 of non-reciprocal circuit element 30c or the electrode of inductance

element section 22a of a branch circuit 37 is pasted up, and the magnet 31 for impressing a direct-current magnetic field further on the magnetic-substance substrate 12 of the resonator portion 24 of non-reciprocal circuit element 30c is arranged. In addition, a magnetic-substance substrate may be formed only in a predetermined portion like this example, and even if it uses a thing of the same shape as a dielectric substrate, it is not cared about. moreover, in case a circuit module like this example is formed Although the method of forming a low dielectric constant film on a dielectric substrate as mentioned above, and forming the resonator portions of the inductance element section or a non-reciprocal circuit element on a low dielectric constant film may be used Form a predetermined electrode pattern in the front rear face of a low dielectric constant substrate, it is made to flow through both in a through hole, and the formation method whose low dielectric constant substrate of the is pinched by the dielectric substrate and the magnetic-substance substrate as shown in drawing 7 may be used.

[0061] Furthermore, different transmitter equipment 60a from the above-mentioned thing of this invention is explained based on drawing 20. In addition, drawing 20 is the schematic diagram of the transmitter equipment of this invention. As shown in drawing 20, transmitter equipment 60a of this example consists of duplexer 40a which consists of a filter for transmission, and a filter for reception, an antenna 53 connected to the means for antenna connection of duplexer 40a, a circuit 51 for transmission connected to the I/O means by the side of the filter for transmission of duplexer 40a, and a circuit 52 for reception which are connected to the I/O means by the side of the filter for reception of a duplexer.

[0062] There is power amplification (PA) in the circuit 51 for transmission, and after a sending signal is amplified by power amplification and goes via an isolator, it is sent from an antenna 53 through the filter for transmission. Moreover, after an input signal is given to the circuit 52 for reception through the filter for reception from an antenna 53 and passes low noise amplifier (LNA), a filter (RX), etc. in the circuit 52 for reception, it is inputted into a mixer (MIX). On the other hand, the local oscillator by the phase locked loop (PLL) consists of VCO (VCO) and a divider (DV), and outputs a local signal to a mixer. And an intermediate frequency is outputted from a mixer. Thus, by constituting, transmitter equipment 60a miniaturized using the non-reciprocal circuit element with sufficient irreversibility by the low propagation loss can be offered.

[0063] In addition, the transmitter equipment of this invention is not restricted to the above-mentioned example, and this invention can be applied also to transmitter equipments 60b and 60c like drawing 21 or drawing 22. That is, transmitter equipment 60b shown in drawing 21 consists of an antenna 53, a circulator (CIR) connected to an antenna 53, and the circuit 51 for transmission and the circuit 52 for reception connected to a circulator (CIR). Power amplification (PA) etc. is included in the circuit for transmission, and low noise amplifier (LNA) etc. is built into the circuit for reception. Moreover, the mixer connected to the power amplification (PA) by which transmitter equipment 60c shown in drawing 22 is included in the circuit for transmission, and it (MIX), And the mixer connected with the low noise amplifier (LNA) built into the circuit for reception at it (MIX), It consists of VCO (VCO) connected to the divider (DIV) connected to both mixers (MIX) at a row, and a divider (DIV), and the isolator (ISO) is connected between a divider (DIV) and VCO (VCO).

[0064]

[Effect of the Invention] As mentioned above, according to this invention, in the compound circuit board which consists of a dielectric substrate, a magnetic-substance substrate, and an electrode pinched among them, the electrode of a position was brought close to a dielectric substrate side, and the electrode of another position was brought close to a magnetic-substance substrate side. If the inductance element section of an electrode is brought close to a magnetic-substance substrate side and the capacitative-element section is brought close to a dielectric substrate side by this, an inductance value and capacity value become large, and if it is the same property, it can miniaturize. Moreover, in an electrode including the transmission line, resistance, etc., since the thickness of a low dielectric constant film can design delicately the physical relationship of a dielectric substrate and a magnetic-substance substrate, the property demanded can be fulfilled easily.

[0065] Moreover, according to the non-reciprocal circuit element of this invention, the resonator portion was brought close to a magnetic-substance substrate side among the electrodes pinched by the dielectric substrate and magnetic-substance substrate of a non-reciprocal circuit element main part, and the transmission-line portion was brought close to a dielectric substrate side. Thereby, the propagation loss of a transmission-line portion decreases, and if it is the still more nearly same property, it can miniaturize compared with the conventional thing. Moreover, since the resonator portion is approaching the magnetic-substance substrate side, the irreversibility of a non-reciprocal circuit element improves. Furthermore, if the low dielectric constant matter is arranged between the resonator portion of an electrode, and a dielectric substrate, compared with the case where form heights in a dielectric substrate, for example, and a resonator portion approaches a magnetic-substance substrate, combination with a resonator portion and a dielectric substrate will become weaker, and irreversibility will improve further.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the plan of the compound circuit board of this invention.
[Drawing 2] It is a X-X line cross section in drawing 1.
[Drawing 3] It is the cross section of the compound circuit board in the second example of this invention.
[Drawing 4] It is the conceptual diagram showing the simulation method.
[Drawing 5] It is drawing showing the relation between a gap, capacity and a gap, and an inductance.
[Drawing 6] It is the cross section showing the modification of this invention.
[Drawing 7] It is the cross section showing other examples of this invention.
[Drawing 8] It is the decomposition perspective diagram of the non-reciprocal circuit element of this invention.
[Drawing 9] It is a Y-Y line cross section in drawing 8.
[Drawing 10] It is the plan of the duplexer of this invention.
[Drawing 11] It is a Z-Z line cross section in drawing 10.
[Drawing 12] It is the schematic diagram of the transmitter equipment of this invention.
[Drawing 13] It is the plan showing other non-reciprocal circuit elements in this invention.
[Drawing 14] It is an A-A line cross section in drawing 13.
[Drawing 15] The non-reciprocal circuit element of drawing 13 is the cross section showing the state where it has been arranged in the crevice of a substrate.
[Drawing 16] It is the decomposition **** view of the non-reciprocal circuit element of further others of this invention.
[Drawing 17] It is A'-A' line cross section in drawing 16.
[Drawing 18] It is the plan of the circuit module of this invention.
[Drawing 19] It is the B-B line cross section which can set drawing 18.
[Drawing 20] It is the schematic diagram showing other transmitter equipments in this invention.
[Drawing 21] It is the schematic diagram showing other transmitter equipments in this invention.
[Drawing 22] It is the schematic diagram showing other transmitter equipments in this invention.
[Drawing 23] It is the plan of the conventional compound circuit board.
[Drawing 24] It is the W-W line cross section which can set drawing 23.
[Description of Notations]
10, 10a, 10b, 10c, 10d compound circuit board
11 Dielectric Substrate
12 Magnetic-Substance Substrate
13 Ground Electrode
14 Low Dielectric Constant Matter, Low Dielectric Constant Film, Low Dielectric Constant Substrate
15 Low Dielectric Constant Substrate Object
16a I/O electrode
16b Connection electrode
17 Through Hole

18 Substrate
19 Electrode Line
20 Electrode, Electrode Pattern, Center Electrode
21 21a Capacitative-element section
22 22a Inductance element section
23 Transmission-Line Section
23a Transmission-line portion
24 Resonator Portion
25 Matching Circuit
26 Insulator Layer
27 Non-reciprocal Circuit Section
30, 30a, 30b, 30c Non-reciprocal circuit element
31 Magnet
32 Case
35 Non-reciprocal Circuit Element Main Part
36 Circuit Module
37 Branch Circuit
38 Resistance Film
40 Duplexer
41 42 Means for I/O connection
43 Means for Antenna Connection
50a The first filter section
50b The second filter section
51 Circuit for Transmission
52 Circuit for Reception
53 Antenna
60, 60a, 60b, 60c Transmitter equipment

[Translation done.]

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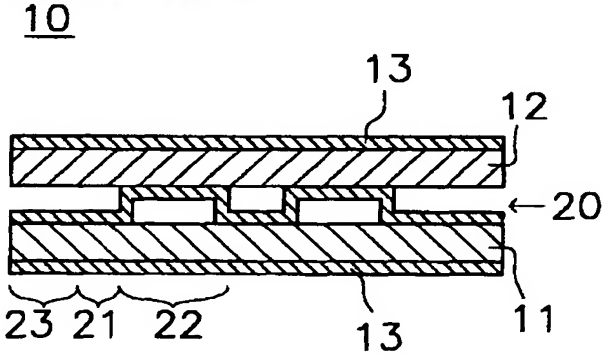
(54)【発明の名称】　複合回路基板、非可逆回路素子、共振器、フィルタ、デュプレクサ、通信機装置、回路モジュール、ならびに複合回路基板の製造方法と非可逆回路素子の製造方法

(57)【要約】
【課題】電極パターンによって形成された素子部分の、誘電体基板と磁性体基板との位置関係を任意の関係に調整可能とし、小型化した複合回路基板を提供する。
【解決手段】誘電体基板11と、該誘電体基板11と間隔を隔てて配置された磁性体基板12と、前記誘電体基板11と前記磁性体基板12との間に形成された電極20とを含んでなる複合回路基板10であって、前記電極20が、容量素子部21を前記誘電体基板11に近接または密接させ、インダクタンス素子部22を前記磁性体基板12に近接または密接させている。



【特許請求の範囲】

【請求項１】誘電体基板と、該誘電体基板と間隔を隔てて配置された磁性体基板と、前記誘電体基板と前記磁性体基板との間に形成された電極とを含んでなる複合回路基板であって、

前記電極が、所定の位置において前記誘電体基板側に相対的に近づいており、前記所定の位置とは異なる他の位置において前記磁性体基板側に相対的に近づいていることを特徴とする複合回路基板。

【請求項２】前記電極が、所定の位置において前記誘電体基板に密接または近接しており、前記所定の位置とは異なる他の位置において前記磁性体基板側に密接または近接していることを特徴とする請求項1記載の複合回路基板。

【請求項３】前記磁性体基板側に近い電極と前記誘電体基板との間に、該誘電体基板の誘電率よりも低い誘電率を有する物質が配置されていることを特徴とする請求項1または2記載の複合回路基板。

【請求項４】前記誘電体基板側に近い電極と、前記磁性体基板側に近い電極とが一体で形成されていることを特徴とする請求項1、2または3記載の複合回路基板。

【請求項５】スルーホールにより導通された表面電極と裏面電極とを有する基板が、前記誘電体基板と前記磁性体基板との間に配置されていることを特徴とする請求項1、2または3記載の複合回路基板。

【請求項６】前記誘電体基板側に近い電極で容量素子が形成され、前記磁性体基板に近い電極でインダクタンス素子が形成されていることを特徴とする請求項1、2、3、4または5記載の複合回路基板。

【請求項７】少なくとも前記誘電体基板に近い電極が存在する部分に、部分的に誘電体基板が配置されている、あるいは少なくとも前記磁性体基板に近い電極が存在する部分に、部分的に磁性体基板が配置されていることを特徴とする請求項1～6記載の複合回路基板。

【請求項８】互いに交差する複数のインダクタンス素子部、および該インダクタンス素子部に接続される容量素子部を有する請求項6または7記載の複合回路基板と、直流磁界を印加するための磁石とを含んでなることを特徴とする非可逆回路素子。

【請求項９】請求項1ないし7記載の複合回路基板の前記誘電体基板と前記磁性体基板との間に配置される電極で容量素子およびインダクタンス素子を形成し、共振回路を構成したことを特徴とする共振器。

【請求項１０】請求項9記載の共振器と、入出力接続用手段とを含んでなることを特徴とするフィルタ。

【請求項１１】少なくとも二つのフィルタと、該フィルタのそれぞれに接続される入出力接続用手段と、前記フィルタに共通的に接続されるアンテナ接続用手段とを含んでなるデュプレクサであって、

前記フィルタの少なくとも一つが請求項10記載のフィルタであることを特徴とするデュプレクサ。

【請求項１２】請求項11記載のデュプレクサと、該デュプレクサの少なくとも一つの入出力接続用手段に接続される送信用回路と、該送信用回路に接続される前記入出力接続用手段と異なる少なくとも一つの入出力接続用手段に接続される受信用回路と、前記デュプレクサのアンテナ接続用手段に接続されるアンテナとを含んでなることを特徴とする通信機装置。

【請求項１３】請求項1～7記載の複合回路基板を用いて形成された少なくとも一つの機能素子を有することを特徴とする回路モジュール。

【請求項１４】誘電体基板と、該誘電体基板と間隔を隔てて配置された磁性体基板と、共振器部分と伝送線路部分とからなり前記誘電体基板と前記磁性体基板との間に形成された電極と、直流磁界を印加するための磁石とを含んでなる非可逆回路素子であって、

前記電極の伝送線路部分において前記誘電体基板側に相対的に近づいており、前記電極の共振器部分において前記磁性体基板側に相対的に近づいていることを特徴とする非可逆回路素子。

【請求項１５】前記電極の伝送線路部分において前記誘電体基板に密接または近接しており、前記電極の共振器部分において前記磁性体基板側に密接または近接していることを特徴とする請求項14記載の非可逆回路素子。

【請求項１６】前記磁性体基板側に近い電極の共振器部分と前記誘電体基板との間に、該誘電体基板の誘電率よりも低い誘電率を有する物質が配置されていることを特徴とする請求項14または15記載の非可逆回路素子。

【請求項１７】スルーホールにより導通された表面電極と裏面電極とを有する基板が、前記誘電体基板と前記磁性体基板との間に配置されていることを特徴とする請求項14、15または16記載の非可逆回路素子。

【請求項１８】少なくとも伝送線路部分となる電極が存在する部分に、部分的に誘電体基板が配置されている、あるいは少なくとも共振器部分となる電極が存在する部分に、部分的に磁性体基板が配置されていることを特徴とする請求項14～17記載の非可逆回路素子。

【請求項１９】請求項14ないし18記載の非可逆回路素子と、送信用回路および受信用回路と、アンテナとを含んでなることを特徴とする通信機装置。

【請求項２０】誘電体基板を用意する工程と、該誘電体基板の誘電率よりも低い誘電率を有する物質で、前記誘電体基板に低誘電率膜を形成する工程と、前記低誘電率膜が形成された誘電体基板に電極パターンを形成する工程と、前記電極パターンが形成された誘電体基板に磁性体基板を接着する工程とを含んでなることを特徴とする複合回路基板の製造方法。

【請求項２１】誘電体基板を用意する工程と、磁性体基板を用意する工程と、前記誘電体基板の誘電率よりも低い誘電率を有する低誘電率基板の表裏面に電極パターン

を形成し、表面電極と裏面電極とをスルーホールで導通させる工程と、前記低誘電率基板を挟むように前記誘電体基板と前記磁性体基板を接着する工程とを含んでなることを特徴とする複合回路基板の製造方法。

【請求項２２】誘電体基板を用意する工程と、前記誘電体基板に電極パターンを形成する工程と、磁性体基板を用意する工程と、前記磁性体基板に電極パターンを形成する工程と、前記誘電体基板の電極パターン面と前記磁性体基板の電極パターン面とが対向し、さらに所定の接続部分において前記誘電体基板の電極パターンと前記磁性体基板の電極パターンとが対向するように配置し、前記所定の接続部分で前記誘電体基板の電極パターンと前記磁性体基板の電極パターンとを接続する工程とを含んでなることを特徴とする複合回路基板の製造方法。

【請求項２３】誘電体基板を用意する工程と、該誘電体基板の誘電率よりも低い誘電率を有する物質で、前記誘電体基板に低誘電率膜を形成する工程と、前記低誘電率膜が形成された誘電体基板の前記低誘電率膜形成部分に共振器部分、その他の部分に伝送線路部分となるように電極パターンを形成する工程と、前記電極パターンが形成された誘電体基板に磁性体基板を接着する工程と、直流磁界を印加するための磁石を用意し配置する工程とを含んでなることを特徴とする非可逆回路素子の製造方法。

【請求項２４】誘電体基板を用意する工程と、磁性体基板を用意する工程と、前記誘電体基板の誘電率よりも低い誘電率を有する低誘電率基板の表裏面に共振器部分と伝送線路部分となる電極パターンを形成し、表面電極と裏面電極とをスルーホールで導通させる工程と、前記低誘電率基板を挟むように前記誘電体基板と前記磁性体基板を、前記電極パターンの共振器部分側に磁性体基板、前記電極パターンの伝送線路部分側に誘電体基板となるように接着する工程と、直流磁界を印加するための磁石を用意し配置する工程とを含んでなることを特徴とする非可逆回路素子の製造方法。

【請求項２５】誘電体基板を用意する工程と、前記誘電体基板に伝送線路部分となる電極パターンを形成する工程と、磁性体基板を用意する工程と、前記磁性体基板に共振器部分となる電極パターンを形成する工程と、前記誘電体基板の電極パターン面と前記磁性体基板と電極パターン面とが対向し、さらに所定の接続部分において前記誘電体基板の電極パターンと前記磁性体基板の電極パターンとが対向するように配置し、前記所定の接続部分で前記誘電体基板の電極パターンと前記磁性体基板の電極パターンとを接続する工程と、直流磁界を印加するための磁石を用意し配置する工程とを含んでなることを特徴とする非可逆回路素子の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、誘電体基板と磁性体基板との間に電極を挟んだ複合回路基板、非可逆回路素子、共振器、フィルタ、デュプレクサ、通信機装置、回路モジュール、ならびに複合回路基板の製造方法と非可逆回路素子の製造方法に関する。

【０００２】

【従来の技術】以前より、容量素子やインダクタンス素子などの電極パターンが形成された誘電体基板や磁性体基板を多段に積層して共振回路などを形成したものが考えられている。また、一方で用途や所望特性などに応じて低背化が求められる場合があり、そのような要求を満たす複合回路基板が、従来より考案されている。

【０００３】そこで、従来の複合回路基板を、図23、24に基づいて説明する。なお、図23は従来の複合回路基板の平面図であり、図24は図23におけるW－W線断面図である。図23、24に示すように、従来の複合回路基板110は、誘電体基板111と、磁性体基板112と、その間に挟まれる電極パターン120とから構成されている。電極パターン120は、容量素子部121とインダクタンス素子部122、伝送線路部123などからなり、誘電体基板111と磁性体基板112の外側面にはアース電極113が形成されている。このような構成にすることにより複合回路基板110は、ここではローパスフィルタとして機能している。

【０００４】この従来の複合回路基板110において、電極パターン120の形成は、まずメッキなどにより誘電体基板111と磁性体基板112それぞれ対向する位置に電極120a、120bを形成し、さらに接続電極120cをその上に形成する。そして、接続電極120cを介して誘電体基板111、磁性体基板112それぞれに形成された電極120a、120bを貼り合わせることで電極パターン120を形成する。

【０００５】

【発明が解決しようとする課題】複合回路基板に形成される容量素子、インダクタンス素子、抵抗や伝送線路などは、誘電体基板との位置関係、磁性体基板との位置関係により、その特性が変化する。例えばインダクタンス素子は、ある程度磁性体基板に近いほうが大きなインダクタンスを得ることができ、同じインダクタンス値では磁性体基板に近いほうが小型化できる。同様に、容量素子は誘電体基板に近いほうが大きな容量を得ることができ、同じ容量値では誘電体基板に近いほうが小型化できる。

【０００６】しかしながら、従来の複合回路基板において、誘電体基板と磁性体基板とに挟まれた電極パターンは、誘電体基板、磁性体基板それぞれに形成された電極を貼り合わせて形成されているので、電極パターンは全て同一平面上にある。つまり、電極パターンにより形成された容量素子、インダクタンス素子、抵抗や伝送線路などは全て誘電体基板と等距離であり、さらに磁性体基板とも等距離ということである。

【０００７】また、インダクタンス素子は磁性体基板に近いほうが大きなインダクタンスを得ることができる

が、近くに誘電体基板があると誘電体との結合が強くなってしまい、インダクタンス値は低下する。また、例えば分布定数型非可逆回路素子の場合、共振器部分と伝送線路部分とからなる電極のうち共振器部分は、磁性体基板に近づけたほうが直流磁界を印加した場合に素子の非可逆性は向上する。しかしながら、近くに誘電体基板があると誘電体との結合が強くなってしまい、素子の非可逆性は低下する。

【０００８】したがって、誘電体基板と磁性体基板とに挟まれる電極パターンで形成された容量素子やインダクタンス素子などが同一平面状にあると、例えばインダクタンス値の向上に限界が生じるなどして、素子の小型化、ひいては複合回路基板の小型化ができないという問題があった。また、容量素子、インダクタンス素子、抵抗や伝送線路などの特性について、微妙な設計ができないという問題があった。

【０００９】本発明の複合回路基板、非可逆回路素子、共振器、フィルタ、デュプレクサ、通信機装置、回路モジュール、ならびに複合回路基板の製造方法と非可逆回路素子の製造方法は、上述の問題を鑑みてなされたものであり、これらの問題を解決し、良好な特性を有し、小型化可能な複合回路基板、非可逆回路素子、共振器、フィルタ、デュプレクサ、通信機装置、回路モジュール、ならびに複合回路基板の製造方法と非可逆回路素子の製造方法を提供することを目的としている。

【００１０】

【課題を解決するための手段】上記目的を達成するため本発明の複合回路基板は、誘電体基板と、該誘電体基板と間隔を隔てて配置された磁性体基板と、前記誘電体基板と前記磁性体基板との間に形成された電極とを含んでなる複合回路基板であって、前記電極が、所定の位置において前記誘電体基板側に相対的に近づいており、前記所定の位置とは異なる他の位置において前記磁性体基板側に相対的に近づいている。これにより、電極パターンにより形成されたインダクタンス素子、容量素子、抵抗や伝送線路などと誘電体基板あるいは磁性体基板との距離を所望の値にできるため、それぞれの素子と誘電体基板や磁性体基板との結合の度合いを個別に設計でき、それぞれの素子の特性を微妙に設計することができる。

【００１１】例えば、磁性体基板としてフェライト基板を用いると、その誘電率は10～15程度であり、誘電正接は1×10^{-3}～1×10^{-4}程度であり、さらに透磁率は1以上である。一方、一般的に用いられる誘電体基板の誘電率は10～100程度であり、誘電正接は5×10^{-4}～1×10^{-5}程度であり、さらに透磁率は1である。このため、容量素子においては誘電体基板に電極を近づけた方が実効誘電率が大きくなり、大きな容量値を得ることができる。また、同じ容量値では電極が誘電体基板に近い方が容量素子を小型化できる。また、伝送損失に関しては、電極を概ね誘電正接の小さい誘電体に近づけた方が、低損失の伝送線路を実現できる。さらに、インダクタンス素子においては磁性体基板に電極を近づけた方が実効透磁率が大きくなり、大きなインダクタンス値を得ることができる。また、同じインダクタンス値では電極は磁性体基板に近い方がインダクタンス素子を小型化できる。

【００１２】また、請求項2に係る複合回路基板は、前記電極が、所定の位置において前記誘電体基板に密接または近接しており、前記所定の位置とは異なる他の位置において前記磁性体基板側に密接または近接している。これにより、誘電体基板に密接または近接した位置の電極は誘電体との結合が強くなり、磁性体基板に密接または近接した位置の電極は磁性体との結合が強くなる。

【００１３】さらに、請求項3に係る複合回路基板は、前記磁性体基板側に近い電極と前記誘電体基板との間に、該誘電体基板の誘電率よりも低い誘電率を有する物質が配置されている。これにより、磁性体基板側に近い電極と誘電体基板との結合を弱めることができ、磁性体に近づけることにより得られる効果が損なわれない。

【００１４】さらにまた、請求項4に係る複合回路基板は、前記誘電体基板側に近い電極と、前記磁性体基板側に近い電極とが一体で形成されている。これにより、誘電体基板に形成された電極と磁性体基板に形成された電極とを接続する必要が無くなり、接続によって生じる信頼性の低下や製造上の手間を省くことができる。

【００１５】さらにまた、請求項5に係る複合回路基板は、スルーホールにより導通された表面電極と裏面電極とを有する基板が、前記誘電体基板と前記磁性体基板との間に配置されている。これにより、誘電体基板および磁性体基板と、それらの間に挟まれる電極が形成された基板との接着により、容易に複合回路基板を形成することができる。

【００１６】さらにまた、請求項6に係る複合回路基板は、前記誘電体基板側に近い電極で容量素子が形成され、前記磁性体基板に近い電極でインダクタンス素子が形成されている。これにより、同じ容量の容量素子では従来に比べ小型化することができ、同じインダクタンスのインダクタンス素子では従来に比べ小型化することができる。

【００１７】さらにまた、請求項7に係る複合回路基板は、少なくとも前記誘電体基板に近い電極が存在する部分に、部分的に誘電体基板が配置されている、あるいは少なくとも前記磁性体基板に近い電極が存在する部分に、部分的に磁性体基板が配置されている。これにより、必要部分にのみ誘電体基板あるいは磁性体基板を配置すればよいので、誘電体基板や磁性体基板の無駄が省ける。

【００１８】さらにまた、請求項8に係る非可逆回路素子は、互いに交差する複数のインダクタンス素子部、および該インダクタンス素子部に接続される容量素子部を有する請求項6または7記載の複合回路基板と、直流磁界

を印加するための磁石とを含んでなる。これにより、非可逆回路素子のインダクタンス素子部が磁性体基板に近づき、容量素子部が誘電体基板に近づいて、非可逆回路素子を小型化できる。

【００１９】さらにまた、請求項9に係る共振器は、請求項1ないし7記載の複合回路基板の前記誘電体基板と前記磁性体基板との間に配置される電極で容量素子およびインダクタンス素子を形成し、共振回路を構成した。これにより、例えば共振器のインダクタンス素子が磁性体基板に近づき、容量素子が誘電体基板に近づくなどして、共振器を小型化できる。

【００２０】さらにまた、請求項10に係るフィルタは、請求項9記載の共振器と、入出力接続用手段とを含んでなる。これにより、例えばフィルタのインダクタンス素子が磁性体基板に近づき、容量素子が誘電体基板に近づくなどして、フィルタを小型化できる。

【００２１】さらにまた、請求項11に係るデュプレクサは、少なくとも二つのフィルタと、該フィルタのそれぞれに接続される入出力接続用手段と、前記フィルタに共通的に接続されるアンテナ接続用手段とを含んでなるデュプレクサであって、前記フィルタの少なくとも一つが請求項10記載のフィルタである。これにより、例えばデュプレクサのインダクタンス素子が磁性体基板に近づき、容量素子が誘電体基板に近づくなどして、デュプレクサを小型化できる。

【００２２】さらにまた、請求項12に係る通信機装置は、請求項11記載のデュプレクサと、該デュプレクサの少なくとも一つの入出力接続用手段に接続される送信用回路と、該送信用回路に接続される前記入出力接続用手段と異なる少なくとも一つの入出力接続用手段に接続される受信用回路と、前記デュプレクサのアンテナ接続用手段に接続されるアンテナとを含んでなる。これにより、例えば通信機装置のインダクタンス素子が磁性体基板に近づき、容量素子が誘電体基板に近づくなどして、通信機装置を小型化できる。

【００２３】さらにまた、本発明の回路モジュールは、請求項1～7記載の複合回路基板を用いて形成された少なくとも一つの機能素子を有する。これにより、例えば回路モジュールのインダクタンス素子が磁性体基板に近づき、容量素子が誘電体基板に近づくなどして、回路モジュールを小型化できる。

【００２４】さらにまた、本発明の非可逆回路素子は、誘電体基板と、該誘電体基板と間隔を隔てて配置された磁性体基板と、共振器部分と伝送線路部分とからなり、前記誘電体基板と前記磁性体基板との間に形成された電極と、直流磁界を印加するための磁石とを含んでなる非可逆回路素子であって、前記電極の伝送線路部分において前記誘電体基板側に相対的に近づいており、前記電極の共振器部分において前記磁性体基板側に相対的に近づいている。これにより、電極の伝送線路部分が誘電体基板に近づいて伝搬損失が小さくなり、同じ特性では従来に比べて小型化する。また、電極の共振器部分が磁性体基板に近づいて磁性体との結合が強くなり、非可逆性が向上する。

【００２５】さらにまた、請求項15に係る非可逆回路素子は、前記電極の伝送線路部分において前記誘電体基板に密接または近接しており、前記電極の共振器部分において前記磁性体基板側に密接または近接している。これにより、誘電体基板に密接または近接した位置の電極は誘電体との結合が強くなり、磁性体基板に密接または近接した位置の電極は磁性体との結合が強くなる。

【００２６】さらにまた、請求項16に係る非可逆回路素子は、前記磁性体基板側に近い電極の共振器部分と前記誘電体基板との間に、該誘電体基板の誘電率よりも低い誘電率を有する物質が配置されている。これにより、磁性体基板側に近い電極と誘電体基板との結合を弱めることができ、磁性体に近づけることにより得られる効果が損なわれない。

【００２７】さらにまた、請求項17に係る非可逆回路素子は、スルーホールにより導通された表面電極と裏面電極とを有する基板が、前記誘電体基板と前記磁性体基板との間に配置されている。これにより、誘電体基板および磁性体基板と、それらの間に挟まれる電極が形成された基板との接着により、容易に非可逆回路素子を形成することができる。

【００２８】さらにまた、請求項18に係る非可逆回路素子は、少なくとも伝送線路部分となる電極が存在する部分に、部分的に誘電体基板が配置されている、あるいは少なくとも共振器部分となる電極が存在する部分に、部分的に磁性体基板が配置されている。これにより、必要部分にのみ誘電体基板あるいは磁性体基板を配置すればよいので、誘電体基板や磁性体基板の無駄が省ける。

【００２９】さらにまた、請求項19に係る通信機装置は、請求項14ないし18記載の非可逆回路素子と、送信用回路および受信用回路と、アンテナとを含んでなる。これにより、非可逆回路素子の伝送線路部分が誘電体基板側に近づいて、共振器部分が磁性体基板側に近づいて、通信機装置の特性が良くなり、さらに通信機装置を小型化できる。

【００３０】さらにまた、請求項20に係る複合回路基板の製造方法は、誘電体基板を用意する工程と、該誘電体基板の誘電率よりも低い誘電率を有する物質で、前記誘電体基板に低誘電率膜を形成する工程と、前記低誘電率膜が形成された誘電体基板に電極パターンを形成する工程と、前記電極パターンが形成された誘電体基板に磁性体基板を接着する工程とを含んでなる。これにより、所定の位置で誘電体基板あるいは磁性体基板に近づいた電極パターンを有する複合回路基板の電極を、一度に形成することができる。

【００３１】さらにまた、請求項21に係る複合回路基板

の製造方法は、誘電体基板を用意する工程と、磁性体基板を用意する工程と、前記誘電体基板の誘電率よりも低い誘電率を有する低誘電率基板の表裏面に電極パターンを形成し、表面電極と裏面電極とをスルーホールで導通させる工程と、前記低誘電率基板を挟むように前記誘電体基板と前記磁性体基板を接着する工程とを含んでなる。これにより、所定の位置で誘電体基板あるいは磁性体基板に近づいた電極パターンを有する複合回路基板を、誘電体基板および磁性体基板と、それらの間に挟まれる電極が形成された基板とを接着することで容易に形成することができる。

【００３２】さらにまた、請求項22に係る複合回路基板の製造方法は、誘電体基板を用意する工程と、前記誘電体基板に電極パターンを形成する工程と、磁性体基板を用意する工程と、前記磁性体基板に電極パターンを形成する工程と、前記誘電体基板の電極パターン面と前記磁性体基板の電極パターン面とが対向し、さらに所定の接続部分において前記誘電体基板の電極パターンと前記磁性体基板の電極パターンとが対向するように配置し、前記所定の接続部分で前記誘電体基板の電極パターンと前記磁性体基板の電極パターンとを接続する工程とを含んでなる。これにより、一般に使用されるフリップチップ実装技術を用いて所定の位置の電極パターンを誘電体基板側に近づけ、別の位置の電極パターンを磁性体基板に近づけることができる。

【００３３】さらにまた、請求項23に係る非可逆回路素子の製造方法は、誘電体基板を用意する工程と、該誘電体基板の誘電率よりも低い誘電率を有する物質で、前記誘電体基板に低誘電率膜を形成する工程と、前記低誘電率膜が形成された誘電体基板の前記低誘電率膜形成部分に共振器部分、その他の部分に伝送線路部分となるように電極パターンを形成する工程と、前記電極パターンが形成された誘電体基板に磁性体基板を接着する工程と、直流磁界を印加するための磁石を用意し配置する工程とを含んでなる。これにより、所定の位置で誘電体基板あるいは磁性体基板に近づいた電極パターンを有する非可逆回路素子の電極を、一度に形成することができる。

【００３４】さらにまた、請求項24に係る非可逆回路素子の製造方法は、誘電体基板を用意する工程と、磁性体基板を用意する工程と、前記誘電体基板の誘電率よりも低い誘電率を有する低誘電率基板の表裏面に共振器部分と伝送線路部分となる電極パターンを形成し、表面電極と裏面電極とをスルーホールで導通させる工程と、前記低誘電率基板を挟むように前記誘電体基板と前記磁性体基板を、前記電極パターンの共振器部分側に磁性体基板、前記電極パターンの伝送線路部分側に誘電体基板となるように接着する工程と、直流磁界を印加するための磁石を用意し配置する工程とを含んでなる。これにより、所定の位置で誘電体基板あるいは磁性体基板に近づいた電極パターンを有する非可逆回路素子を、誘電体基板および磁性体基板と、それらの間に挟まれる電極が形成された基板とを接着することで容易に形成することができる。

【００３５】さらにまた、請求項25に係る非可逆回路素子の製造方法は、誘電体基板を用意する工程と、前記誘電体基板に伝送線路部分となる電極パターンを形成する工程と、磁性体基板を用意する工程と、前記磁性体基板に共振器部分となる電極パターンを形成する工程と、前記誘電体基板の電極パターン面と前記磁性体基板と電極パターン面とが対向し、さらに所定の接続部分において前記誘電体基板の電極パターンと前記磁性体基板の電極パターンとが対向するように配置し、前記所定の接続部分で前記誘電体基板の電極パターンと前記磁性体基板の電極パターンとを接続する工程と、直流磁界を印加するための磁石を用意し配置する工程とを含んでなる。これにより、一般に使用されるフリップチップ実装技術を用いて所定の位置の電極パターンを誘電体基板側に近づけ、別の位置の電極パターンを磁性体基板に近づけることができる。

【００３６】

【発明の実施の形態】以下、本発明の実施例である複合回路基板を、図1、2に基づいて説明する。なお、図1は、本発明の複合回路基板の平面図であり、図2は図1におけるX－X線断面図である。図1、2に示すように、本発明の複合回路基板10は、誘電体基板11と、磁性体基板12と、それらの間に挟まれる電極パターン20とから構成されている。電極パターン20は、容量素子部21やインダクタンス素子部22、あるいは伝送線路部23などからなり、例えば$CaTiO_3$からなる誘電体基板11とフェライトからなる磁性体基板12の外側面にはアース電極13が形成されている。図1のような構成にすることにより複合回路基板10は、ここではローパスフィルタとして機能している。

【００３７】図2に示すように、本発明の複合回路基板10において、電極パターン20の容量素子部21は誘電体基板11に密接しており、インダクタンス素子部22は磁性体基板12に密接している。このように、容量素子部21を誘電体基板11に密接させると、容量素子部21の容量値が大きくなる。したがって、同じ容量値の従来構造における複合回路基板に比べて小型化できる。また、インダクタンス素子部22を磁性体基板12に密接させると、誘電体基板11との結合が弱くなり、インダクタンス素子部22のインダクタンス値が大きくなる。したがって、同じインダクタンス値の従来構造における複合回路基板に比べて小型化できる。さらに、伝送線路部23やここでは図示していないが抵抗などについても、誘電体基板11と磁性体基板12との距離関係によって伝搬損失が変化するなどの影響がある。したがって、伝送線路部23や抵抗の配置位置を、誘電体基板11と磁性体基板12の間のどの位置にするかによって、伝送線路部23や抵抗の特性を微妙に設計でき、容易に要求特性に合致させることができる。

【００３８】次に、本発明の複合回路基板における第二の実施例を、図3に基づいて説明する。なお、先の実施例と同一部には同符号を付し、詳細な説明は省略する。図3に示すように、本実施例の複合回路基板10aは、誘電体基板11と、磁性体基板12と、それらの間に挟まれる電極パターン20と、電極パターン20と誘電体基板11とで挟まれる低誘電率物質14とから構成されている。なお、ここで低誘電率物質14とは、誘電体基板11の誘電率よりも小さい誘電率を有する物質であり、さらには、磁性体基板12の誘電率よりも小さい誘電率を有する物質であればなお良い。誘電体基板11と電極パターン20との間に低誘電率物質14が挟まれる位置は、インダクタンス素子部22が形成される位置であり、例えば誘電体基板11に凸部を形成してインダクタンス素子部22が磁性体基板12に近づく場合に比べて、低誘電率物質14によりインダクタンス素子部22は誘電体基板11との結合が弱まる。つまり、磁性体基板12との結合によって得られる効果が誘電体基板11との結合によって低減させられることを、例えば誘電体基板11に凸部を形成してインダクタンス素子部22を磁性体基板12に近づける場合に比べて、この低誘電率物質14が防ぐ。

【００３９】なお、以上の実施例において、誘電体基板と磁性体基板とで挟まれる電極パターンは、一方において誘電体基板あるいは磁性体基板に密接しているが、磁性体基板に密接するインダクタンス素子は、磁性体基板との間に低誘電率物質を挟むなどして、磁性体基板と近接させると良い。このことを、シミュレーション結果に基づいて説明する。

【００４０】図4は、間隔を隔てて配置された誘電体基板11と磁性体基板12の間に電極20を設けた概念図であり、図5はその電極20と誘電体基板11とのギャップGと、インダクタンスLの関係およびギャップGと容量Cの関係を示すシミュレーション結果である。なお、誘電体基板11は厚み0.5mm、誘電率90、透磁率1であり、磁性体基板12は厚み0.5mm、誘電率15、透磁率3である。また、誘電体基板11と磁性体基板12の間隔は0.03mmであり、電極20の厚みは0.01mmである。また、△は容量Cを示し、○はインダクタンスLを示す。図5に示すように、容量Cは誘電体基板11に密接しているほうが大きくなるが、インダクタンスLは磁性体基板12から0.005mm離れた位置が最大となっている。すなわち、インダクタンス素子部は磁性体基板12に密接させるより近接させる方が良いということである。

【００４１】また、これらの実施例においては、誘電体基板と磁性体基板とに挟まれる電極パターンは、磁性体基板に密接または近接しているが、これに限るものではない。例えば、図6に示す複合回路基板10bのように、磁性体基板12と電極パターン20との間に低誘電率基板体15を挟むなどして、電極パターン20が全て誘電体基板11側に近い場合でも、インダクタンス素子部22は容量素子部21に比較して磁性体基板12側に相対的に近づいている。このような場合においても、本発明の効果は得られる。

【００４２】以下に、本発明の複合回路基板の製造方法について説明する。まず、一方の面にアース電極が形成された誘電体基板を用意し、インダクタンス素子となる位置の誘電体基板にエポキシ樹脂やポリイミド樹脂などにより低誘電率膜を形成する。その後、低誘電率膜を含む誘電体基板上に容量素子、インダクタンス素子や伝送線路などの電極パターンをメッキやスパッタリングなどにより形成する。そして、一方の面にアース電極が形成された磁性体基板を接着することで、第二の実施例に示すような複合回路基板が得られる。この製造方法を用いると、電極パターンを一度に形成することができ、従来の接続電極を用いて接続する方法に比べて容易に複合回路基板を形成することができる。

【００４３】なお、この実施例においては、誘電体基板と電極パターンとの密着性を重視して、誘電体基板側に電極パターンを形成する例を示したが、逆に磁性体基板側に電極パターンを形成しても構わない。但し、この実施例で示した製造方法を用いると、電極パターンと磁性体基板との間の接着層がそのまま低誘電率層となって、インダクタンス素子部で磁性体基板との間に適度なギャップを設けることができる。また、ここでは低誘電率膜を一層のみ設ける例を示したが、低誘電率膜を場所によっては多層にし、電極パターンで形成されたそれぞれの素子ごとに誘電体基板や磁性体基板との距離を適当な距離にして、複合回路基板の特性を微妙に設計することもできる。

【００４４】さらに、他の製造方法について説明する。まず、樹脂基板などの低誘電率基板の表裏面に電極パターンを設ける。ここでは例えば、一方の面にインダクタンス素子となる電極パターンを形成し、他方の面に容量素子や伝送線路となる電極パターンを形成し、表裏面の電極パターンをスルーホール17により導通させる。そして、一方の面にアース電極が形成された誘電体基板および磁性体基板の間に、電極パターンが形成された低誘電率基板を挟み接着する。このような製造方法により、図7に示すような複合回路基板10cが得られる。

【００４５】次に、本発明の非可逆回路素子を、図8、9に基づいて説明する。なお、図8は本発明の非可逆回路素子の分解斜視図であり、図9は図8における複合回路基板部分のY－Y線断面図である。図8、9に示すように、本発明の非可逆回路素子30は、複合回路基板10d部分と、直流磁界を印加するための磁石31と、それらを収納するケース32とから構成されている。複合回路基板10d部分は、誘電体基板11と、フェライトなどからなる磁性体基板12と、それらの間に挟まれる中心電極20とからなる。中心電極20は、それぞれ120°の角度で交差した三本の電極で、一端を入出力電極側に接続され、他端はアースに接続されている。

【００４６】中心電極20を形成する際には、例えば裏面にアース電極13が形成された誘電体基板11において中心電極20のインダクタンス素子部22となる位置に低誘電率膜14を形成し、メッキなどによりインダクタンス素子部22および整合を取るための容量素子部21を含む一本の中心電極20を形成する。その後、絶縁膜26を間に挟んで二本目の中心電極20を一本目と同様にして形成し、さらに三本目の中心電極20を形成する。そして、中心電極20が形成された誘電体基板11にアース電極13が形成された磁性体基板12を接着し、複合回路基板10d部分が形成される。三本の中心電極20それぞれの一方端は、接続電極16bなどにより誘電体基板11の裏面に形成されたアース電極13とは絶縁される入出力電極16aと接続され、他端はスルーホール17などにより、誘電体基板11裏面のアース電極13に接続されている。このようにして形成された複合回路基板10dが、磁性体基板12の上部に配置される磁石31とともにケース32に収納されることによって非可逆回路素子30は構成されている。

【００４７】本実施例の非可逆回路素子30においては、誘電体基板11に形成された低誘電率膜14上にインダクタンス素子部22を形成し、誘電体基板11上に容量素子部21を形成することにより、インダクタンス素子部22は磁性体基板12側に近づき、容量素子部21は誘電体基板11側に近づいている。したがって、同じ特性を有する従来の非可逆回路素子に比べてインダクタンス素子部22、容量素子部21が共に小さくなるので、非可逆回路素子30自体も小型化できる。

【００４８】さらに、本発明のデュプレクサ40を、図10、11に基づいて説明する。なお、図10はデュプレクサの平面図であり、図11は図10におけるZ－Z線断面図である。図10、11に示すように、本実施例のデュプレクサ40は、ストリップライン型フィルタからなる第一フィルタ部50aと、別のストリップライン型フィルタからなる第二フィルタ部50bとからなる。第一フィルタ部50aを構成するフィルタは、送信用帯域通過フィルタとなり、第二フィルタ部50bを構成する、第一フィルタ部50aとは異なる共振周波数を有する共振器が形成されたフィルタは受信用帯域通過フィルタとなる。第一フィルタ部50aの入出力接続用手段41は、外部の送信用回路に接続され、第二フィルタ部50bの入出力接続用手段42は、外部の受信用回路に接続されている。さらに、第一フィルタ部50aの他方の入出力接続用手段と、第二フィルタ部50bの他方の入出力接続用手段とは、アンテナ接続用手段43に統合され、外部のアンテナに接続されている。

【００４９】このような構成のデュプレクサ40は、第一フィルタ部50aで所定の周波数を通過させ、第二フィルタ部50bで先の周波数とは異なる周波数を通過させる帯域通過デュプレクサとして機能する。

【００５０】本実施例のデュプレクサ40においては、誘電体基板11に形成された低誘電率膜14上にフィルタのインダクタンス素子部22を形成し、誘電体基板11上にフィルタの容量素子部21を形成することにより、インダクタンス素子部22は磁性体基板12側に近づき、容量素子部21は誘電体基板11側に近づいている。したがって、同じ特性を有する従来のデュプレクサに比べてインダクタンス素子部22、容量素子部21は共に小さくなるので、フィルタは小型化し、ひいてはデュプレクサ40も小型化できる。

【００５１】さらにまた、本発明の実施例である通信機装置60を、図12に基づいて説明する。なお、図12は本実施例の通信機装置の概略図である。図12に示すように、本実施例の通信機装置60は、デュプレクサ40と、送信用回路51と、受信用回路52と、アンテナ53とから構成されている。ここでデュプレクサ40は、先の実施例で示したものであり、図10における第一フィルタ部50aと接続される入出力接続用手段が、送信用回路51に接続されており、第二フィルタ部50bと接続される入出力接続用手段が、受信用回路52に接続されている。また、アンテナ接続用手段43は、アンテナ53に接続されている。

【００５２】本実施例の通信機装置60においては、誘電体基板に形成された低誘電率膜上にインダクタンス素子部を形成し、誘電体基板上に容量素子部を形成することにより、インダクタンス素子部は磁性体基板側に近づき、容量素子部は誘電体基板側に近づいている。したがって、同じ特性を有する従来の通信機装置に比べてインダクタンス素子部、容量素子部は共に小さくなるので、通信機装置60自体も小型化できる。

【００５３】以下に本発明の前述のものとは異なる非可逆回路素子を、図13、14に基づいて説明する。なお、図13は本発明の非可逆回路素子の平面図であり、図14は図13におけるA－A線断面図である。図13、14に示すように、本実施例の非可逆回路素子30aは、非可逆回路素子本体35と、非可逆回路素子本体35の上部に配置され、非可逆回路素子本体35に直流磁界を印加するための磁石31とから構成されている。非可逆回路素子本体35は、一方の面にアース電極13が形成された誘電体基板11および磁性体基板12と、それらの間に挟まれる電極パターン20とから構成されており、電極パターン20は、中心の共振器部分24と、互いに120°の交差角を有する伝送線路部分23aとから構成されている。また、伝送線路部分23aには共振器部分24と伝送線路部分23aとの整合を取るための整合回路部分25が設けられている。

【００５４】このようにして形成された非可逆回路素子本体35は、例えば図15に示すように凹部の設けられた基板18の凹部内に、誘電体基板11側を下にして配置され、磁性体基板12上における電極パターン20の共振器部分24に対応する位置に磁石31が配置される。そして、伝送線路部分23aの端部と基板18に形成された電極ライン19とがワイヤボンディングや、接続電極などにより接続される。このとき、磁性体基板12は少なくとも電極パターン

20の共振器部分24上に存在すれば良く、誘電体基板11より一回り小さい磁性体基板12を用いることで、伝送線路部分23aの端部が表面に現れて基板28の電極ライン19と接続することができる。

【００５５】本実施例の非可逆回路素子本体35を形成する際には、まず電極パターン20における共振器部分24にあたる位置の誘電体基板11上に低誘電率膜14を形成する。そして、低誘電率膜14を含む誘電体基板11上に共振器部分24、伝送線路部分23aからなる電極パターン20を形成し、さらに磁性体基板12を接着する。この方法により電極パターン20を一度に形成することができ、容易に非可逆回路素子30aを製造することができる。また、非可逆回路素子本体の別の形成方法としては、上述した図7のような構成を用いることが考えられる。すなわち、低誘電率基板の一方の面に共振器部分となる電極パターンを形成し、他方面に伝送線路部分となる電極パターンを形成する。そして、表裏面の電極パターンをスルーホールなどにより接続してから、共振器部分の面側に磁性体基板を、伝送線路部分の面側に誘電体基板を接着する。この方法によっても電極パターンを一度に形成することができ、容易に非可逆回路素子を製造することができる。

【００５６】さらに、本発明の非可逆回路素子の別の実施例を図16、17に基づいて説明する。なお、図16は本実施例の非可逆回路素子の分解斜視図であり、図17はA' －A' 線断面図である。図16、17に示すように本実施例の非可逆回路素子30bは、誘電体基板11と磁性体基板12と磁石31とから構成されており、誘電体基板11には互いに120°の交差角を有する三つの伝送線路部分23bからなる電極パターン20が形成され、磁性体基板12にも互いに120°の交差角を有する非可逆回路部27となる電極パターン20が形成されている。さらに、伝送線路部分23bには整合回路部分25が形成されている。そして、誘電体基板11における電極パターン20が形成された面と、磁性体基板12における電極パターン20が形成された面とが対向するように配置し、誘電体基板11の伝送線路部分23bと磁性体基板12の非可逆回路部27とを三ヶ所でそれぞれ接続する。このような接続を行う際には、例えば磁性体基板12に形成された非可逆回路部27の三つの端点にはんだバンプや金バンプを形成し、その磁性体基板12をいわゆるフリップチップ実装にて誘電体基板11上に実装する。なお、図16には示していないが誘電体基板11上には非可逆回路素子の他に種々の機能素子が形成されており、それらがそれぞれ接続されて回路が構成されている。

【００５７】上記実施例の非可逆回路素子においては、図14、17に示すように、非可逆回路素子本体35の電極パターン20における共振器部分24および非可逆回路部27が磁性体基板12側に近づいており、伝送線路部分23aは誘電体基板11側に近づいている。伝送線路部分23aを誘電体基板11に近づけることにより伝送線路部分23aにおける伝搬損失は低減し、同じ特性の従来のものに比べて小型化できる。一方、共振器部分24、非可逆回路部23bを磁性体基板12に近づけることにより非可逆性が向上する。また、先の実施例においては電極パターン20の共振器部分24と誘電体基板11との間に低誘電率物質14が存在することにより、共振器部分24と誘電体基板11との距離が大きくなるので、例えば誘電体基板11に凸部を形成して共振器部分24が磁性体基板12に近づく場合に比べて、共振器部分24と誘電体基板11との結合がさらに弱まり、非可逆回路素子30aの非可逆性が向上する。また、後の実施例においては電極パターン20が形成された磁性体基板12を必要な部分にのみフリップチップ実装すればよいので、磁性体基板12の無駄が無くなる。また、汎用のバンプ接続などのフリップチップ実装技術を用いることが可能で、製造が容易になる。

【００５８】なお、上述の非可逆回路素子においては、三端子のものを用いて説明したが、三端子のうちの一端に終端抵抗を接続してアイソレータとしたものや、二端子のアイソレータにも本発明は適用できる。

【００５９】次に、同一基板上に複数の素子を形成した回路モジュールに本発明を適用した例を、図18、19に基づいて説明する。なお、図18は本実施例の回路モジュールの平面図であり、図19は図18におけるB－B線断面図である。図18、19に示すように本実施例の回路モジュール36は、機能素子としての非可逆回路素子30c部分と分岐回路37部分とから構成されている。非可逆回路素子30cは一つの端子に抵抗膜38が接続されたアイソレータであり、一方、分岐回路37は容量素子部21aとインダクタンス素子部22aと抵抗膜38とから構成されている。

【００６０】このような回路モジュール36を形成する際には、まずアース電極13が形成された誘電体基板11上の所定の部分、つまり非可逆回路素子30cの共振器部分24や分岐回路37のインダクタンス素子部22aとなる部分に低誘電率膜14を形成し、低誘電率膜14を含む誘電体基板11上に非可逆回路素子30cおよび分岐回路37の電極パターン20を形成する。また、非可逆回路素子30cおよび分岐回路37それぞれに抵抗膜38を形成する。そして、非可逆回路素子30cの共振器部分24や分岐回路37のインダクタンス素子部22aの電極上にアース電極13が形成された磁性体基板12を接着して、さらに非可逆回路素子30cの共振器部分24の磁性体基板12上には直流磁界を印加するための磁石31を配置する。なお、磁性体基板は本実施例のように所定部分のみに形成してもよいし、誘電体基板と同形のものを用いても構わない。また、本実施例のような回路モジュールを形成する際には、上述のように誘電体基板上に低誘電率膜を形成して、低誘電率膜上にインダクタンス素子部や非可逆回路素子の共振器部分を形成する方法を用いても構わないが、低誘電率基板の表裏面に所定の電極パターンを形成して両者をスルーホールで導通させ、その低誘電率基板を誘電体基板と磁性体基

板とで挟む、図7に示したような形成方法を用いても構わない。

【００６１】さらに、本発明の前述のものとは異なる通信機装置60aを、図20に基づいて説明する。なお、図20は本発明の通信機装置の概略図である。図20に示すように、本実施例の通信機装置60aは、送信用フィルタおよび受信用フィルタからなるデュプレクサ40aと、デュプレクサ40aのアンテナ接続用手段に接続されるアンテナ53と、デュプレクサ40aの送信用フィルタ側の入出力手段に接続される送信用回路51と、デュプレクサの受信用フィルタ側の入出力手段に接続される受信用回路52とから構成されている。

【００６２】送信用回路51にはパワーアンプ（PA）があり、送信信号はパワーアンプにより増幅され、アイソレータを経由した後、送信用フィルタを通してアンテナ53から発信される。また、受信信号はアンテナ53から受信用フィルタを通して受信用回路52に与えられ、受信用回路52におけるローノイズアンプ（LNA）やフィルタ（RX）などを通過した後、ミキサ（MIX）へ入力される。一方、フェーズロックループ（PLL）による局部発振器は、発振器（VCO）とディバイダ（DV）とからなり、ローカル信号をミキサへ出力する。そして、ミキサから中間周波数が出力される。このように構成することにより、低伝搬損失で非可逆性の良い非可逆回路素子を用いて、小型化した通信機装置60aを提供できる。

【００６３】なお、本発明の通信機装置は上記の実施例に限るものではなく、例えば図21や図22のような通信機装置60b、60cにも本発明は適用できる。すなわち、図21に示す通信機装置60bは、アンテナ53と、アンテナ53に接続されるサーキュレータ（CIR）と、サーキュレータ（CIR）に接続される送信用回路51と受信用回路52とから構成されている。送信用回路にはパワーアンプ（PA）などが組み込まれ、受信用回路にはローノイズアンプ（LNA）などが組み込まれている。また、図22に示す通信機装置60cは、送信用回路に組み込まれているパワーアンプ（PA）とそれに接続されるミキサ（MIX）、および受信用回路に組み込まれているローノイズアンプ（LNA）とそれに接続されるミキサ（MIX）、ならびに両ミキサ（MIX）に接続されるディバイダ（DIV）、そしてディバイダ（DIV）に接続される発振器（VCO）とから構成され、ディバイダ（DIV）と発振器（VCO）との間にアイソレータ（ISO）が接続されている。

【００６４】

【発明の効果】以上のように本発明によれば、誘電体基板と、磁性体基板と、それらの間に挟まれる電極とからなる複合回路基板において、所定の位置の電極を誘電体基板側に近づけ、別の位置の電極を磁性体基板側に近づけた。これにより、例えば電極のインダクタンス素子部を磁性体基板側に近づけ、容量素子部を誘電体基板側に近づけると、インダクタンス値、容量値が大きくなり、同じ特性ならば小型化できる。また、伝送線路や抵抗などをも含めた電極において、誘電体基板と磁性体基板との位置関係を低誘電率膜の厚みによって微妙に設計できるので、要求される特性を容易に満たすことができる。

【００６５】また、本発明の非可逆回路素子によれば、非可逆回路素子本体の誘電体基板と磁性体基板とに挟まれる電極のうち、共振器部分を磁性体基板側に近づけ、伝送線路部分を誘電体基板側に近づけた。これにより、伝送線路部分の伝搬損失が低減し、さらに、同じ特性であるならば、従来のものに比べて小型化できる。また、共振器部分が磁性体基板側に近づいているので、非可逆回路素子の非可逆性が向上する。さらに、電極の共振器部分と誘電体基板との間に低誘電率物質を配置すると、例えば誘電体基板に凸部を形成して共振器部分が磁性体基板に近づく場合に比べて共振器部分と誘電体基板との結合が弱まり、さらに非可逆性が向上する。

【図面の簡単な説明】

【図１】本発明の複合回路基板の平面図である。

【図２】図1におけるＸ－Ｘ線断面図である。

【図３】本発明の第二の実施例における複合回路基板の断面図である。

【図４】シミュレーション方法を示す概念図である。

【図５】ギャップと容量、ギャップとインダクタンスとの関係を表す図である。

【図６】本発明の変形例を示す断面図である、

【図７】本発明の他の実施例を示す断面図である。

【図８】本発明の非可逆回路素子の分解斜視図である。

【図９】図8におけるＹ－Ｙ線断面図である。

【図１０】本発明のデュプレクサの平面図である。

【図１１】図10におけるＺ－Ｚ線断面図である。

【図１２】本発明の通信機装置の概略図である。

【図１３】本発明における他の非可逆回路素子を示す平面図である。

【図１４】図13におけるＡ－Ａ線断面図である。

【図１５】図13の非可逆回路素子が、基板の凹部に配置された状態を示す断面図である。

【図１６】本発明のさらに他の非可逆回路素子の分解射視図である。

【図１７】図16におけるA'－A'線断面図である。

【図１８】本発明の回路モジュールの平面図である。

【図１９】図18のおけるＢ－Ｂ線断面図である。

【図２０】本発明における他の通信機装置を示す概略図である。

【図２１】本発明における他の通信機装置を示す概略図である。

【図２２】本発明における他の通信機装置を示す概略図である。

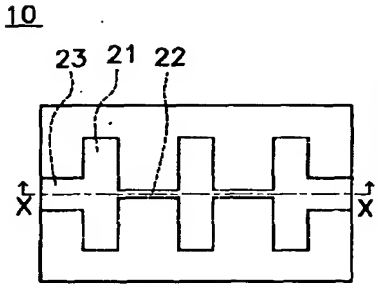
【図２３】従来の複合回路基板の平面図である。

【図２４】図23のおけるＷ－Ｗ線断面図である。

【符号の説明】

10, 10a, 10b, 10c, 10d	複合回路基板
11	誘電体基板
12	磁性体基板
13	アース電極
14	低誘電率物質、低誘電率膜、低誘電率基板
15	低誘電率基板体
16a	入出力電極
16b	接続電極
17	スルーホール
18	基板
19	電極ライン
20	電極、電極パターン、中心電極
21, 21a	容量素子部
22, 22a	インダクタンス素子部
23	伝送線路部
23a	伝送線路部分
24	共振器部分
25	整合回路
26	絶縁膜
27	非可逆回路部
30, 30a, 30b, 30c	非可逆回路素子
31	磁石
32	ケース
35	非可逆回路素子本体
36	回路モジュール
37	分岐回路
38	抵抗膜
40	デュプレクサ
41, 42	入出力接続用手段
43	アンテナ接続用手段
50a	第一フィルタ部
50b	第二フィルタ部
51	送信用回路
52	受信用回路
53	アンテナ
60, 60a, 60b, 60c	通信機装置

【図１】



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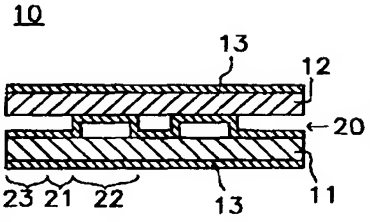

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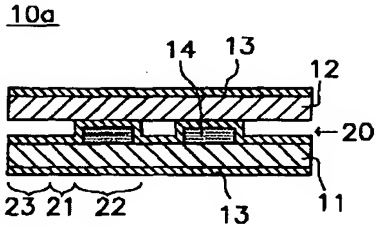
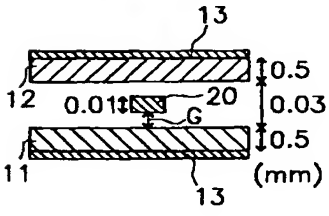


【図６】

【図４】



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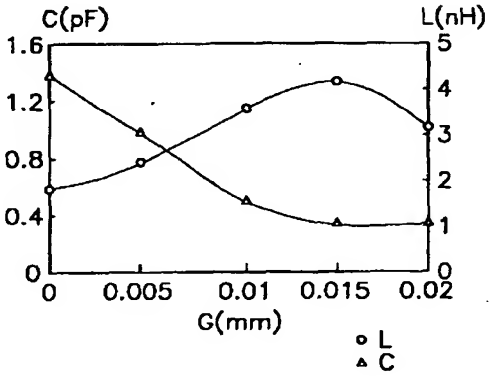

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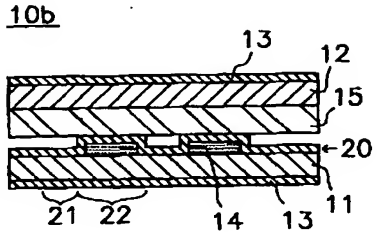

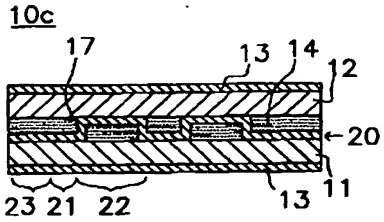

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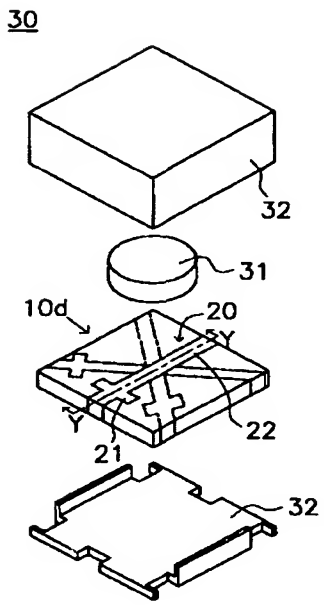

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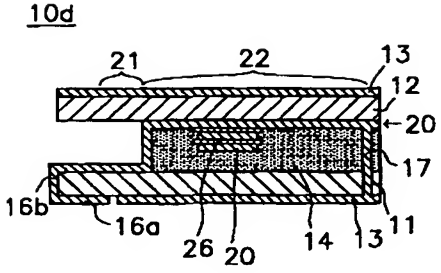

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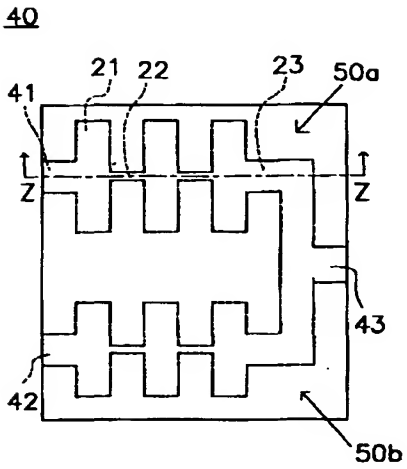

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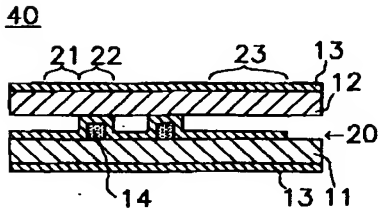

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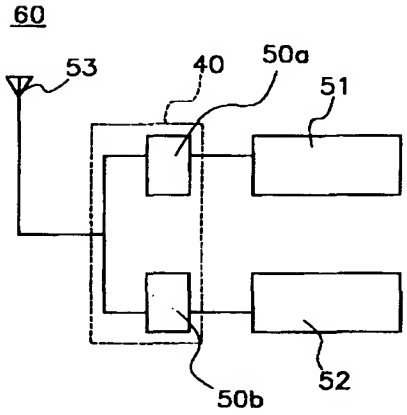

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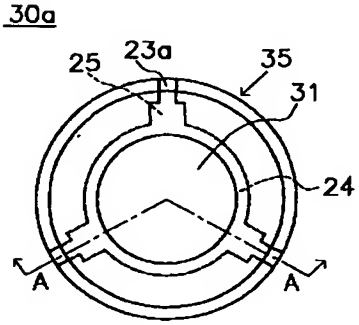

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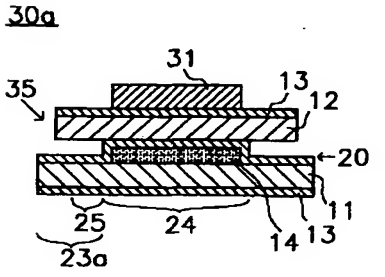

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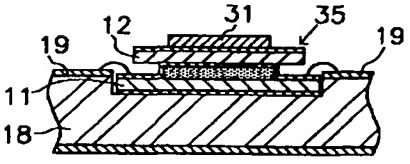

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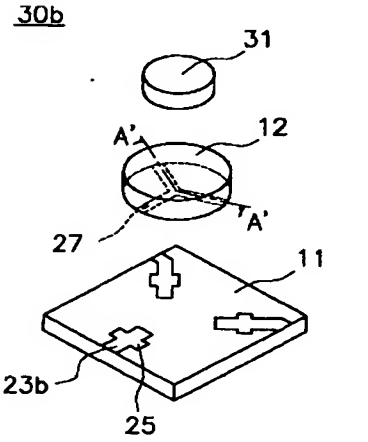

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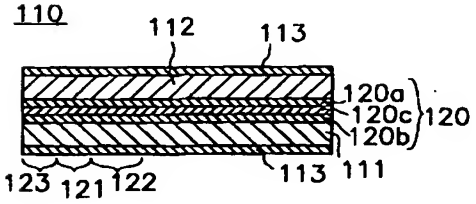

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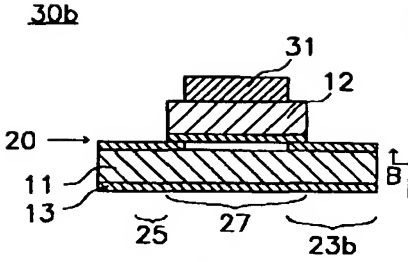

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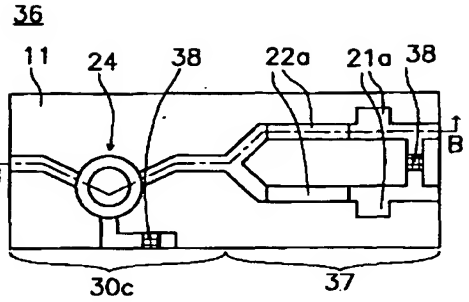

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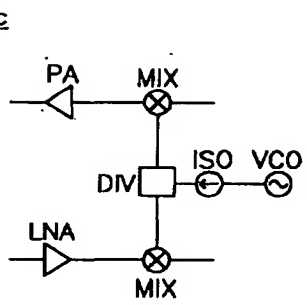

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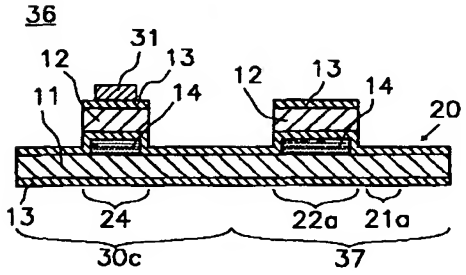

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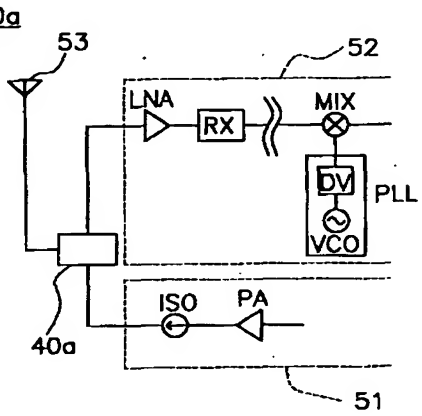

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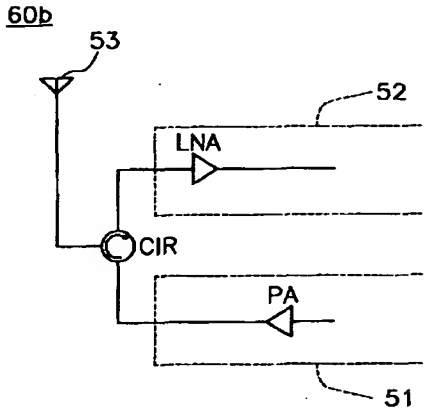

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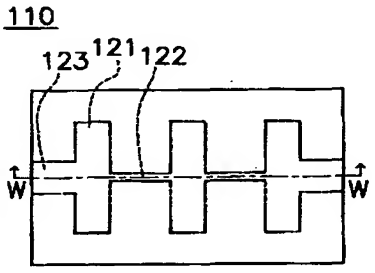

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(51) Int. Cl.[7]	識別記号	F I	ﾃｰﾏｺｰﾄﾞ(参考)
H01P 11/00		H01P 11/00	G